Medical Education Systems, Inc.

Course 712

CPAP Compliance

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CPAP COMPLIANCE ISSUES

Table of Contents

Learning Objectives

Upon successful completion of this course, you will be able to:

- Define and discuss CPAP
- Explain what is meant by "compliance" in the context of CPAP treatment
- Discuss why compliance is so important
- List and discuss the factors that affect compliance rates
- Identify the actions that caregivers can take to increase patient compliance

This course presents you with a variety of readings from a variety of viewpoints regarding the issues associated with patient compliance with their CPAP instructions.

What is Continuous Positive Airway Pressure (CPAP)?

Snoring Problems

Forty-five percent of normal adults snore at least occasionally, and 25 percent are habitual snorers. Problem snoring is more frequent in males and overweight persons and it usually grows worse with age. Snoring sounds are caused when there is an obstruction to the free flow of air through the passages at the back of the mouth and nose.

Only recently have the adverse medical effects of snoring and its association with Obstructive Sleep Apnea (OSA) and Upper Airway Resistance Syndrome (UARS) been recognized. Various methods are used to alleviate snoring and/or OSA. They include behavior modification, sleep positioning, Continuous Positive Airway Pressure (CPAP), Uvulopalatopharyngoplasty (UPPP), and Laser Assisted Uvula Palatoplasty (LAUP), and jaw adjustment techniques.

What Is Continuous Positive Airway Pressure (CPAP)?

Nasal CPAP delivers air into your airway through a specially designed nasal mask or pillows. The mask does not breathe for you; the flow of air creates enough pressure when you inhale to keep your airway open. CPAP is considered the most effective nonsurgical treatment for the alleviation of snoring and obstructive sleep apnea.

If your otolaryngologist determines that the CPAP treatment is right for you, you will be required to wear the nasal mask every night. During this treatment, you may have to undertake a significant change in lifestyle. That change could consist of losing weight, quitting smoking, or adopting a new exercise regimen.

Before the invention of the nasal CPAP, a recommended course of action for a patient with sleep apnea or habitual snoring was a tracheostomy, or creating a temporary opening in the windpipe. The CPAP treatment has been found to be nearly 100 percent effective in eliminating sleep apnea and snoring when used correctly and will eliminate the necessity of a surgical procedure.

So, If I Use A Nasal CPAP I Will Never Need Surgery?

With the exception of some patients with severe nasal obstruction, CPAP has been found to be nearly 100 percent effective, although it does not cure the problem. However, studies have shown that long-term compliance in wearing the nasal CPAP is about 70 percent.

Some people have found the device to be claustrophobic or have difficulty using it when traveling. If you find that you cannot wear a nasal CPAP each night, a surgical solution might be necessary. Your otolaryngologist will advise you of the best course of action.

Should You Consider CPAP?

If you have significant sleep apnea, you may be a prime for CPAP. Your otolaryngologist will evaluate you and ask the following questions:

- Do you snore loudly and disturb your family and friends?
- Do you have daytime sleepiness?
- Do you wake up frequently in the middle of the night?
- Do you have frequent episodes of obstructed breathing during sleep?
- Do you have morning headaches or tiredness?

Suitability for CPAP use is determined after a review of your medical history, lifestyle factors (alcohol and tobacco intake as well as exercise), cardiovascular condition, and current medications. You will also receive a physical and otorhinolaryngological (ear, nose, and throat) examination to evaluate your airway.

Before receiving the nasal mask, you would need to have the proper CPAP pressure set during a "sleep study." This will complete the evaluation necessary for prescribing the appropriate treatment for your needs.

What is compliance anyway? And Why is CPAP Compliance Important?

Compliance simply means that a patient is carrying out a prescribed treatment plan exactly as directed. In most cases, this will mean that their condition, disorder or disease is cured, or under control. The treatment plan can be as simple as taking medications or as complicated as doing physical therapy. In the case of OSA (**O**bstructive **S**leep **A**pnea), it means proper use of a CPAP machine on a regular basis.

When patients don't comply with treatment, the consequences can be very negative for the patient. The patient continues suffering from the complex of OSA symptoms and complications that can include fatigue, confusion, falling asleep at inappropriate times and decreased productivity. Many fatal and non-fatal victims of stroke and heart attack may have avoided death or disability, if their OSA had been diagnosed and treated prior to the occurrence of the catastrophic event. Furthermore, individuals with OSA at the moderate to severe level are 4.5 times as likely to have coronary heart disease, myocardial infarction, and angina as are those without sleep apnea. On the other hand, we have seen patients whose hypertension and Congestive Heart Failure (CHF) were completely reversed by successful treatment of their severe OSA.

Multiple factors influence compliance

We are convinced beyond the shadow of a doubt from our experience that treatment compliance and its associated benefits rise dramatically with high quality patient training, education, communication and follow up. A great example from a different area of medicine is diabetes. It has been repeatedly demonstrated that when well educated, informed patients comply with treatment, and proactively manage their condition, the incidence of secondary complications is dramatically reduced or eliminated. This results in higher quality of life for the patient, less visits to the physician over time, and reduced cost to treat these patients.

While CPAP compliance is difficult to track, several studies indicate that it is influenced by a variety of factors. These include; severity of the disease, quality of patient training and education, initial success/problems, participation in a support group, mask-related comfort and claustrophobia, follow-up and monitoring by health care professionals, patient motivation, use of humidification, treatment reactions, and patient age. One of the reasons for SleepQuest's successful compliance rate is that our high-quality training, education, and long term monitoring identify these problem early and address them immediately, before they have a chance to affect the patients' motivation and treatment success.

A little knowledge goes a long way

There are some simple yet effective guidelines that can help you achieve high compliance and treatment success. 1) Be proactive and learn as much as you can about OSA and your particular machine. 2) Follow your doctor's instructions exactly and use the machine on a regular basis. Often, the difference between using the CPAP occasionally and on a regular basis is dramatic. 3) If you encounter any problems at any time in your treatment, work with your doctor or CPAP health care specialist to resolve them.

CPAP compliance works!

The bottom line is that when patients use their machines on a regular basis, their condition is managed, they get the sleep that they need which means they're not suffering from daytime fatigue, and worrying about work performance. You can get back to doing what is really important - getting on with your life.

Obstructive Sleep Apnea-Hypopnea Syndrome

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Obstructive sleep apnea-hypopnea syndrome (OSAHS) is characterized by repetitive episodes of airflow reduction (hypopnea) or cessation (apnea) due to upper airway collapse during sleep. Increasing recognition and a greater understanding of the scope of this condition have substantially affected the practices of many clinicians. This review provides practical information for physicians assessing patients with OSAHS. It discusses complications, clinical recognition, the polysomnographic report, and treatment of OSAHS, including strategies for troubleshooting problems associated with continuous positive airway pressure therapy.

AASM = American Academy of Sleep Medicine; AHI = apnea-hypopnea index; BMI = body mass index; CMS = Centers for Medicare and Medicaid Services; CPAP = continuous positive airway pressure; NREM = non–rapid eye movement; OSAHS = obstructive sleep apnea-hypopnea syndrome; REM = rapid eye movement; RERA = respiratory effort–related arousal; UARS = upper airway resistance syndrome

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Obstructive sleep apnea-hypopnea syndrome (OSAHS) is characterized by repetitive episodes of airflow reduction due to pharyngeal narrowing, leading to acute gas exchange abnormalities and sleep fragmentation and resulting in neurobehavioral and cardiovascular consequences. During sleep, critical narrowing of the upper airway occurs behind the uvula and soft palate, at the base of the tongue, or at both sites; it develops because of a dysfunctional interplay of anatomical factors and compensatory neuromuscular mechanisms insufficient to maintain airway patency. Obstructive sleep apnea-hypopnea syndrome may be considered part of a spectrum of sleep-related breathing disorders that includes the upper airway resistance syndrome (UARS) and primary snoring. Upper airway resistance syndrome is characterized by hypersomnolence caused by recurrent respiratory effort–related arousals (RERAs)[1] without overt apneas or hypopneas. Snoring is the sound of pharyngeal vibration triggered by airflow turbulence across a narrowed upper airway and when present without affecting respiration or the patient's sleep quality is termed *primary snoring*.

Because of a greater appreciation of the ramifications of OSAHS, clinicians are more aware of this syndrome, and the demand for sleep medicine services has accelerated. During the past decade, the number of sleep centers accredited by the American Academy of Sleep Medicine (AASM) and the number of sleep specialists credentialed by the American Board of Sleep Medicine have increased by approximately 300%.

Despite such growth in the sleep medicine enterprise, waiting lists at sleep disorders centers are long, and the vast majority of patients remain undiagnosed.[2] The increasing prevalence of obesity[3] and a better understanding of the link between OSAHS and cardiovascular disease[4] will substantially affect the health care delivery system.

CONSEQUENCES OF OSAHS

Neurobehavioral and Social

Excessive daytime sleepiness, impaired vigilance, mood disturbances, and cognitive dysfunction are features of OSAHS. Accordingly, pretreatment personal and public health ramifications include increased risk for motor vehicle crashes, occupational injuries, and decreased quality of life.[5] Performance deficits during neuropsychological testing can be documented with even mild OSAHS. With a frequency of 15 apneas-hypopneas per hour of sleep, the decrement is equivalent to that associated with 5 years of aging.[6] Vulnerability to sleepiness resulting from OSAHS varies considerably among patients. Partners of patients with OSAHS experience poor sleep,[7] and often it is the partner who prompts the sleep evaluation, seeking relief from loud snoring and disturbing apneas.

Cardiovascular

An OSAHS-hypertension link has been suspected for years because of clinical observations and biologic plausibility. The intermittent hypoxia, negative intrathoracic pressure variations, and arousals characteristic of apneas and hypopneas lead to acute increases in blood pressure at the termination of disordered breathing events, evolving into sustained hypertension via chronically heightened sympathetic nervous system activity and arterial baroreceptor dysfunction.[4] The strongest evidentiary association comes from the Wisconsin Sleep Cohort Study, an ongoing study of state employees undergoing serial in-laboratory polysomnography, which has shown a dose-dependent link between apnea-hypopnea frequency at baseline and the development of hypertension at follow-up.[8] For a baseline apnea-hypopnea frequency of 15/h, the odds ratio for hypertension at 4 years was 2.89 (95% confidence interval, 1.46-5.64) vs zero events per hour, after adjusting for known confounding variables. Hypertension in the setting of OSAHS may be more difficult to treat. Sleep apnea is listed first in the table of identifiable causes of hypertension in the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure.[9] Data on the effect of OSAHS treatment on blood pressure are mixed; some intervention studies show a positive effect.[5]

TABLE 1. DIFFERENTIAL DIAGNOSIS OF THE SLEEPY PATIENT
Too little time in bed
Insufficient sleep syndrome
Impaired sleep quality
Obstructive sleep apnea-hypopnea syndrome
Upper airway resistance syndrome
Central sleep apnea syndrome
Restless legs syndrome-periodic movement disorder
Intrinsic sleepiness
Narcolepsy
Idiopathic hypersomnia
Recurrent hypersomnia
Irregular timing of sleep-wake pattern
Shift work sleep

disorder	
Delayed-advanced sleep phase syndrome	
Time zone change (jet lag) syndrome	
Medical-psychiatric comorbidity	
Cardiopulmonary disease	
Mood disorders	
Alcoholism	
Medications	

Large population-based studies have associated OSAHS with cardiovascular and cerebrovascular disease, and retrospective data indicate untreated OSAHS is associated with increased mortality. The Sleep Heart Health Study has shown cross-sectional, dose-dependent associations between OSAHS and vascular disease.[10] More than 6000 subjects from multiple longitudinal cardiovascular cohorts were studied with in-home polysomnography. For those in the highest quartile of apnea-hypopnea frequency (≥11/h), the multivariable adjusted odds of self-reported cardiovascular disease was 1.42 (95% confidence interval, 1.13-1.78) with the strongest links to heart failure and stroke.[10] Although a skeptical person might conclude that the association of OSAHS with cardiovascular disease is modest, it is seen within a range of apnea-hypopnea frequencies (5-15 events per hour) that occur in 1 of every 15 adults.[5] Prospective data indicating that OSAHS treatment positively affects cardiovascular morbidity or mortality are minimal; however, a recent study showed that optimal treatment of heart failure could not be achieved until OSAHS was eliminated.[11]

Perioperative and Postoperative

Patients with OSAHS may have an increased perioperative risk, but data quantifying the risk are limited. In such patients, endotracheal intubation may be more difficult, and forced supine sleep positioning and analgesics can result in upper airway narrowing postoperatively.

A retrospective study of 101 patients who underwent hip or knee replacement and who had or were later found to have OSAHS vs 101 age-, sex-, and operation-matched controls found that the percentage of patients with complications was higher (39% in the OSAHS group vs 18% in the control group) and hospital stay was longer (6.8±2.8 vs 5.1±4.1 days) in the OSAHS group.[12] Only 12 of 33 patients who were using continuous positive airway pressure (CPAP) therapy at home preoperatively were prescribed CPAP therapy in the hospital postoperatively and before the development of complications, and only 3 patients had planned to use CPAP therapy in the postanesthesia recovery area.

RECOGNITION OF OSAHS

History and Physical Examination

The history focuses on breathing disturbances during sleep, unsatisfactory sleep quality, daytime dysfunction, and OSAHS risk factors. A collateral history should be obtained from the patient's bed partner. Reports of habitual, socially disruptive snoring and witnessed apneas terminated by snorts or gasps increase diagnostic accuracy. Sleepiness lacks diagnostic sensitivity and specificity (Table 1). The onset of sleepiness may be so insidious that the patient is unaware of its development, and the symptom is more commonly due to chronic insufficient time in bed in the general population. Obstructive sleep apnea-hypopnea syndrome is 2 to 3 times more prevalent in men.[13] This sex-protective effect is diminished in premenopausal overweight women (body mass index [BMI] ≥32 kg/m^2), menopausal women not receiving hormone replacement therapy, and overweight women receiving hormone replacement therapy.[13] Prevalence appears to plateau after age 65 years.[14] Other risk factors may include smoking, alcohol, and nasal congestion.[5]

The physical examination focuses on craniofacial and soft tissue conditions associated with increased upper airway resistance, such as retrognathia, deviated nasal septum, low-lying soft palate, enlarged uvula, and base of tongue. The preponderance of evidence suggests a causal role for obesity (BMI >28 kg/m^2) in OSAHS.[5] Neck circumference of 43 cm or greater tends to make the retropharyngeal space shallow and has been highly correlated with OSAHS.[15] After controlling for BMI and neck circumference, tonsillar enlargement (defined as lateral impingement >50% of the posterior pharyngeal airspace) and narrowing of the airway by the lateral pharyngeal walls (defined as impingement >25% of the pharyngeal space by peritonsillar tissues, excluding the tonsils) are also predictive of OSAHS.[15] Because OSAHS is not considered capable of causing severe increases in right heart pressures without a comorbid condition producing persistent hypoxemia,[16] severe pulmonary hypertension should prompt investigation for coexisting disorders.

Prediction Models

The cardinal features of OSAHS—namely, snoring and excessive sleepiness—are highly prevalent in the general population. Nearly 40% of outpatients in a survey of urban primary care practices reported clinical characteristics (BMI >30 kg/m^2, hypertension, snoring, sleepiness, and tiredness) that suggested OSAHS[17]; however, the estimated prevalence of undiagnosed OSAHS is 5% in the middle-aged population.[5] Prediction models based on various combinations of symptoms, demographics, and anthropometric parameters have been proposed to help clinicians determine the probability of OSAHS. Four clinical prediction models applied prospectively to a large group of patients referred for OSAHS evaluation performed equivalently and without distinction (sensitivities, >75%; specificities, <55%; positive predictive values, 69%-77%).[18] There is no consensus on the optimal prediction formula, and such models have not been widely used in clinical practice.

Pulse Oximetry

Obstructive apneas and hypopneas result in repetitive "sawtooth" oscillations in the oxyhemoglobin saturation on a time-compressed profile. Published sensitivities and sensitivities vary widely because of nonstandardized oximetry data sampling and study populations. For diagnosing OSAHS, pulse oximetry is not considered a singularly sufficient alternative to polysomnography. The utility of pulse oximetry may lie at the extremes of the OSAHS spectrum.[19] If clinical suspicion for OSAHS is high, pulse oximetry may help triage the timing of polysomnography when entry to a sleep center is delayed. If clinical suspicion is low, normal study findings effectively exclude OSAHS. However, RERAs are not detectable by pulse oximetry because arousals occur before ventilation or oxyhemoglobin saturation is compromised. Therefore, sleepy patients with normal findings on oximetry require further evaluation.

LABORATORY DIAGNOSIS OF OSAHS

The diagnosis of OSAHS is based on an integration of clinical information and laboratory testing. The recommended diagnostic test for sleep-related breathing disorders is polysomnography.[20] The standard polysomnogram is a laboratory-based, technician-attended multimodality recording of sleep architecture by electroencephalography, electro-oculography, and electromyography; respiratory activity by nasal and oral airflow or pressure, thoracoabdominal inductance plethysmography, and oximetry; electrocardiography; limb movements by lower extremity electromyography; and body position. Adjunctive measures may include a sound meter to detect snoring, endtidal carbon dioxide determination when OSAHS is being investigated in children, and, rarely, esophageal pressure monitoring if RERAs or central sleep apnea is suspected.

Definitions of Disordered-Breathing Events

Obstructive apneas and hypopneas are characterized by repetitive periods of complete (apnea) or partial (hypopnea) airflow reduction. The event must be at least 10 seconds in duration in association with respiratory efforts, and it usually ends with arousal from sleep.[1] Identification of hypopnea also requires an accompanying decrease in oxyhemoglobin saturation. The requisite desaturation is controversial, although hypopnea criteria from both the Clinical Practice Review Committee of the AASM[21] and the Centers for Medicare and Medicaid Services (CMS) stipulate a decrease in oxyhemoglobin saturation of 4% or greater. An RERA is a series of breaths occurring for at least 10 seconds associated with an ever-increasing respiratory effort against a narrowed upper airway that terminates with arousal from sleep before criteria for a true apnea or hypopnea event are met.[1] With esophageal pressure monitoring, RERAs are marked by progressively negative esophageal pressure deflections (reflecting increasing work of breathing) during the breaths immediately preceding an arousal. Upper airway resistance syndrome is the condition of excessive sleepiness associated with 10 or more RERAs per hour.[22]

Reviewing the Polysomnographic Results

The principal factor for the clinician to note is the apnea-hypopnea index (AHI), defined as the number of apneas and hypopneas per hour of sleep. A similar but not necessarily equivalent term is the *respiratory disturbance index*. The respiratory disturbance index may be used to report the number of apneas and hypopneas per hour of recording in limited study montages that do not measure sleep. Furthermore, the respiratory disturbance index may be used by some sleep laboratories to report the number of apneas, hypopneas, and RERAs per hour of sleep. By consensus, OSAHS is defined by an AHI of 5 or greater with evidence of unsatisfying or disturbed sleep, daytime sleepiness, or other daytime symptoms or when the AHI is 15 or higher. The AHI specific for sleep position (lateral decubitus vs supine) and sleep stage (non–rapid eye movement [NREM] vs rapid eye movement [REM]) may be reported separately because of potential therapeutic implications. An AASM expert panel has recommended that, at least for purposes of standardizing research methodology, mild OSAHS be defined by an AHI of 5 to 14, moderate by an AHI of 15 to 30, and severe by an AHI greater than 30.[1]

Other polysomnographic factors help reveal the extent of physiologic perturbations caused by OSAHS. The arousal index, defined as the number of arousals per hour of sleep (normal, <20/h), is increased by apneas, hypopneas, and/or RERAs. Sleep architecture figures often reveal increases in stage 1 NREM (normal, 5% of sleep) and decreases in stage 3/4 NREM (normal, 15%-20% in young adults; decreases with age) and REM (normal, 20%). The depth of desaturation by oximetry depends on the duration of the apneas-hypopneas and the underlying lung function. Pronounced ventricular ectopy in patients with OSAHS is uncommon unless oxyhemoglobin desaturation is severe or underlying heart disease is present.[23]

Other Diagnostic Test Strategies

Numerous efforts have been made to modify standard polysomnography because it is cumbersome for patients, labor intensive, and difficult to access in many laboratories. One strategy that has been validated is split night polysomnography—the initial diagnostic portion is followed on the same night by CPAP titration.[20] A variety of more limited diagnostic monitoring systems, some designed for unattended home use, are being used. The role for these systems remains uncertain. The CMS mandates that, for CPAP reimbursement purposes, the diagnosis of OSAHS must be established by a facility-based (not in the home or mobile facility) polysomnogram and that the AHI be based on at least 120 minutes of sleep. Nonetheless, technological advances and access pressures predict further efforts to tailor the extent of diagnostic testing to the pretest probability of OSAHS.

TREATMENT OF OSAHS

Obstructive sleep apnea-hypopnea syndrome is a chronic disease that requires patient education, alleviation of upper airway obstruction, and ongoing follow-up with adjustment of treatment strategies to ensure efficacy. Because many patients with OSAHS are overweight or have comorbid cardiovascular risk factors or diseases, they must be informed of the interaction of OSAHS and overall health. Prospective data on the cardiovascular and perioperative benefits of OSAHS treatment are emerging, but the current, most widely accepted patient and physician treatment target is hypersomnolence.[24]

Conservative Maneuvers

In many patients, lifestyle modifications will decrease both the symptoms of OSAHS and the comorbid conditions.[25] Lifestyle changes include weight loss, alcohol-sedative avoidance, smoking cessation, avoidance of sleep deprivation, and, if appropriate, sleep position restriction. Longitudinal data from the Wisconsin Sleep Cohort Study indicate that a 10% weight loss predicts a 26% decrease in the AHI.[26]

Continuous Positive Airway Pressure

The decision to treat OSAHS usually means a trial use of CPAP, a device that pneumatically splints the upper airway during inspiration and expiration. A placebo-controlled, randomized trial[24] showed that CPAP decreases sleepiness and increases quality of life. During polysomnography, CPAP is titrated to a level that eliminates snoring, RERAs, and apneas-hypopneas and is then most often prescribed at a "fixed" level, typically at the pressure necessary to maintain airway patency during conditions of greatest vulnerability (REM sleep while supine). For most patients, the prescribed pressure is in the 7- to 11-cm H_2O range. CPAP systems consist of a blower connected to a nasal interface by a flexible 180-cm hose, all weighing approximately 2.2 kg and transportable in a soft-sided case. Criteria from CMS for

reimbursement for CPAP are an AHI of 15 or greater or an AHI of 5 to 14 with documented symptoms of excessive sleepiness, impaired cognition, mood disorders, or insomnia; or documented hypertension or ischemic heart disease; or history of stroke.

Monitoring and Optimizing the CPAP Experience

Follow-up of a patient should occur shortly after initiation of CPAP therapy and annually thereafter.[27] The following 5 questions, posed annually or at times of change in health status, should enable clinicians to assess their patients using CPAP.

1. What interferes with your use of CPAP?
2. Are you sleepy during the day?
3. Does your bed partner observe snoring or breathing pauses when you use CPAP?
4. How has your weight changed since CPAP therapy was initially prescribed or last adjusted?
5. When was the last time your CPAP equipment was assessed?

Usage patterns and problems with CPAP vary among patients. The minimum effective CPAP use time is unknown, but improvements in objective daytime sleepiness have been shown when average use is less than 4 hours per night.[28] Nightly vs intermittent (suboptimal compliance) CPAP use patterns may be established within the first several weeks to a month,[29] highlighting the importance of early support. An important component is patient education.[30] The patient (and partner) must understand the importance of treating OSAHS, how CPAP works and why it was chosen, and the specific features of the CPAP equipment. Patient characteristics that consistently predict CPAP compliance have not been identified. Only a few comprehensive, long-term compliance studies have been published,[31,32] and they indicate that continuing CPAP use generally correlates with AHI severity, average nightly use of fewer than 2 hours at 3 months predicts failure, and ongoing use at 5 years is 65% to 90%. Many units now have downloadable compliance monitoring capability.

The most commonly encountered problems with CPAP therapy and suggested interventions, admittedly more experience based than evidence based, are listed in Table 2. Tolerating the prescribed pressure is a common hurdle at the outset. Clinicians can remind their patients to use the CPAP ramp, a feature on all new machines that allows a gradual increase in the pressure from a base of 3 to 4 cm H_2O to the prescribed level at 5 to 45 minutes. This can be reset at any time.

Autotitrating CPAP devices can be recommended; they are perhaps most useful for patients with marked differences in pressure requirements due to body position or sleep stage.

The proprietary systems within these units allow dynamic variations in delivered pressure in response to changes in pharyngeal pressure, airflow, or vibration; therefore, the lowest appropriate pressure can be administered for the given circumstance. These systems provide equivalent positive effects on sleep and breathing factors at lower mean pressures compared with standard CPAP systems and have been shown in some, but not all, studies to produce modest increases in compliance.[33] Use of unattended autotitrating devices in CPAP-naive patients to determine a fixed CPAP or to initiate therapy without polysomnography is not currently recommended.[34] Conventional[35] and novel[36] bilevel systems capable of independent adjustment of inspiratory and expiratory pressures are an option but have not been shown in randomized trials to improve compliance.

The basic patient interfaces are nasal masks, oronasal masks, and nasal pillows (Figure 1). Many variations in mask configurations, headgears, and cushioning materials are available. Patients struggling with tightness of masks can be reassured that CPAP blowers will compensate for air leaks if the mask is loosened slightly. Nasal irritation (congestion, dripping, dryness, sneezing) is the most common problem after initial acclimatization to CPAP therapy. Patients can be advised to obtain a heated humidifier or activate one already integrated into many of the newer blowers. Heated humidification has been shown to improve CPAP compliance compared with no added humidity.[37] The humidifier reservoir must be emptied and air dried daily, then refilled with fresh distilled water at bedtime.

TABLE 2. TROUBLESHOOTING GUIDE FOR COMMON CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP)-RELATED PROBLEMS

Challenge	Solutions
Difficulty tolerating pressure	Have sleep center or vendor evaluate blower to ensure pressure as prescribed Activate CPAP ramp feature Wear CPAP device while awake (daily practice)

	Lower pressure by 1 to 2 cm H_2O* Return to sleep center for consideration of autoadjusting CPAP or bilevel positive airway pressure therapy	
Intolerance of interface	Loosen mask slightly Ensure that mask or pillows are situated properly Rule out interface modification by patient Return to sleep center or vendor for resizing Use barrier, such as moleskin or bandage, for bridge of nose irritation Inspect interface; replace if	

	deteriorated
Nasal irritation	Use nasal saline spray before bed Use heated CPAP humidifier Use nasal corticosteroid spray Use ipratropium bromide nasal spray if rhinorrhea is present Ensure that patient is cleaning and air drying CPAP humidifier reservoir daily
Claustrophobic response	Have sleep center or vendor fit patient with nasal pillows or sleeker mask Wear CPAP device while awake (daily practice) Telephone sleep center for support or desensitization

	plan
Difficulty initiating sleep with CPAP	Wear CPAP device while awake (daily practice) Reinforce good sleep hygiene (warm bath before bed, exercise program, decrease caffeine and alcohol use, limit time in bed to 8 h) Delay bedtime until very sleepy Prescribe brief sedative-hypnotic trial
Dry mouth	Add chin strap Have sleep center or vendor fit patient for oronasal mask Add CPAP-heated humidifier
Removal of CPAP device unintentionally during sleep	Reasure patient that this is normal Assess all other

	headgear-nasal interface problems, especially nasal congestion Add humidification Add chin strap Lower pressure alarm on blower unit For severe cases: set alarm at night for patients to check headgear; progressively set alarm later with improvement	
*Empirical reductions in the level of CPAP to enhance adherence to therapy must be made cautiously because too much of a reduction in pressure may result in reemergence of sleep-disordered breathing events.		

Symptoms that persist despite optimal CPAP compliance should prompt reappraisal of the patient. The caregiver should also be ready to investigate the possible presence of a concurrent sleep disorder (Table 1). The differential diagnosis for persistent sleepiness during CPAP therapy includes technical problems (incorrect use of mask, pressure incorrectly set by vendor or improperly altered by patient); pressure not accurately determined during the initial sleep study; prescribed pressure invalidated by patient weight gain or increases in alcohol, sedative, or narcotic use; or a concurrent sleep disorder.

If breakthrough snoring is reported, upper airway obstruction is not fully relieved, and the CPAP level needs upward adjustment, the nasal interface needs replacement or the interface may not be situated properly during sleep. The blower should be assessed at least annually, and the nasal interface should be evaluated and/or replaced every 6 months.

Changes in the patient's weight or medical condition may require alteration of the treatment plan. Management options in response to weight gain include overnight oximetry with referral to a sleep disorders center if findings are abnormal or an empirical increase of 1 to 2 cm H_2O if symptoms of OSAHS have reemerged or oximetry findings are abnormal. Conversely, clinical experience suggests that a 10% weight loss may allow an empirical reduction in pressure by 1 to 2 cm H_2O; greater weight loss requires formal reevaluation.

Other Options

Oral appliances have been developed for mechanically enlarging or stabilizing the upper airway by advancing the mandible or tongue. The mandible is usually set forward 5 to 11 mm (50%-75% of maximal protrusion). Subjective improvements in snoring are reported in most case series with oral appliances; approximately 50% of patients achieve an AHI lower than 10, and long-term compliance rates are 50% to 100%.[38] Randomized crossover comparisons reveal that CPAP devices are more effective at lowering the AHI[39] than oral appliances, which are most appropriate for patients with mild to moderate OSAHS.

Uvulopalatopharyngoplasty, an operation that modifies the retropalatal airway by excision of the uvula, a portion of the soft palate, and tonsils (if present), produces mixed results. Although snoring is usually subjectively improved, objective improvements have not been well documented. Furthermore, less than 50% of patients achieve an apnea index lower than 10 and at least a 50% reduction in apneas.[40] Laser-assisted uvulopalatoplasty is not currently recommended for the treatment of OSAHS.[41] Radiofrequency ablation techniques can be applied focally to reduce the size of the palate and base of tongue, but efficacy data are limited. Other surgical options include tracheostomy (used rarely) and oral maxillofacial procedures.

CONCLUSION

Even mild OSAHS can be associated with pronounced behavioral, social, and cardiovascular morbidity. Thus, it is not surprising that patients with untreated OSAHS have higher health care utilization rates and incur greater medical costs.[42] Further data are needed to define the specific cardiovascular risks of untreated OSAHS and to determine the extent of the impact of treatment. Clinicians should suspect OSAHS in patients with habitually loud snoring; witnessed apneas, choking, or gasping during sleep; hypertension; neck circumferences of 43 cm or greater; obesity; and laterally narrowed oropharynxes.

The threshold for initiating a sleep center referral should be lower when 1 or more clinical features are severe, serious comorbidities are present, major surgery is being planned, and/or additional risk factors for OSAHS are identified. Referral efforts should be more vigilant when patient or public safety issues arise, such as with commercial motor vehicle or airplane operation.

The patient with suspected primary snoring should also be considered for further evaluation if careful questioning suggests excessive daytime sleepiness (raising the possibility of UARS) or when occult OSAHS might complicate management of a comorbidity, such as hypertension. Overnight oximetry has little additive diagnostic value in the patient with suspected classic OSAHS. Polysomnography is the recommended approach to assessing patients for apneas, hypopneas, and RERAs and for titrating CPAP. Our understanding of what constitutes a sufficient diagnostic method continues to evolve. The AHI is the traditional marker for OSAHS but may not convey the full physiologic impact of sleep-disordered breathing. CPAP is the treatment of choice for most patients with OSAHS. Heated humidification helps decrease CPAP-associated nasal irritation and is a recommended accessory for most patients in whom CPAP therapy is being initiated. Early follow-up is necessary because use patterns are established within the first month.

Self-Test Questions About OSAHS

1. Which *one* of the following is *not* independently associated with untreated OSAHS?

   a. Systemic hypertension
   b. Stroke
   c. Motor vehicle crash
   d. Excessive daytime sleepiness
   e. Fibromyalgia

2. Which *one* of the following statements is *false* regarding recognition of OSAHS?

   a. Prevalence of OSAHS rises inevitably each year after age 65 years
   b. Snoring and sleepiness are not specific for OSAHS
   c. OSAHS is an underappreciated component of the preoperative evaluation
   d. Neck circumference of 43 cm or greater correlates with OSAHS
   e. Male sex confers a higher risk for OSAHS

3. Which *one* of the following statements regarding the diagnosis of sleep-disordered breathing is *false*?

   a. Polysomnography is the recommended diagnostic test
   b. A sleepy snorer with normal findings on overnight oximetry does not have sleep-disordered breathing

c. OSAHS is defined by an AHI of 5 or more plus daytime symptoms
d. RERAs are arousals from sleep due to an ever-increasing breathing effort against a narrowed airway before apnea or hypopnea occurs
e. UARS is associated with 10 or more RERAs per hour of sleep

4. Which *one* of the following statements regarding treatment of OSAHS is *false*?

a. CPAP pneumatically splints the upper airway during sleep
b. CPAP can be administered via nasal masks, nasal prongs, or oronasal masks
c. Oral appliances are generally less effective in lowering the AHI when compared directly to CPAP devices
d. The AASM currently recommends laser-assisted uvuloplasty as a treatment option for OSAHS
e. A 10% weight reduction may translate into a 26% AHI reduction

5. Which *one* of the following statements about CPAP is *true*?

a. CPAP blowers and masks need to be checked every 2 years
b. Long-term compliance rates are less than 40%
c. Heated humidification improves compliance
d. Autotitrating CPAP devices consistently produce substantially higher increases in patient compliance compared to standard CPAP devices
e. Standard CPAP devices automatically compensate for changes in patient weight

Correct answers: 1. *e*, 2. *a*, 3. *b*, 4. *d*, 5. *c*

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Long-term Compliance Rates to Continuous Positive Airway Pressure in Obstructive Sleep Apnea*

A Population-Based Study

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Abstract

Study objectives: To determine long-term compliance rates to continuous positive airway pressure (CPAP) therapy in patients with obstructive sleep apnea enrolled in a comprehensive CPAP program in the community.

Design: Prospective cohort longitudinal study.

Setting: University sleep disorders center.

Patients: Two hundred ninety-six patients with an apnea-hypopnea index (AHI) ≥20/h on polysomnography.

Interventions: A CPAP device equipped with a monitoring chip was supplied. Within the first week, daily telephone contacts were made. Patients were seen at 2 weeks, 4 weeks, 3 months, and 6 months.

Results: Of the 296 subjects enrolled, 81.1% were males. Mean ± SD AHI was 64.4 ± 34.2/h of sleep; age, 51 ± 11.7 years; and body mass index, 35.2 ± 7.9 kg/m^2. The mean duration of CPAP use was 5.7 h/d at 2 weeks, 5.7 h/d at 4 weeks, 5.9 h/d at 3 months, and 5.8 h/d at 6 months. The percentage of patients using CPAP ≥3.5 h/d was 89.0% at 2 weeks, 86.6% at 4 weeks, 88.6% at 3 months, and 88.5% at 6 months. There was a decrease in the Epworth Sleepiness Scale (ESS) score of 44% by 2 weeks of therapy. The

patients continue to improve over the follow-up period, with the lowest mean ESS score observed at 6 months. With multiple regression analysis, three variables were found to be significantly correlated with increased CPAP use: female gender, increasing age, and reduction in ESS score.

Conclusion: A population-based CPAP program consisting of consistent follow-up, "troubleshooting," and regular feedback to both patients and physicians can achieve CPAP compliance rates of > 85% over 6 months.

Key Words: compliance rate • continuous positive airway pressure • obstructive sleep apnea

Introduction

Obstructive sleep apnea (OSA) is a common condition affecting 2% of adult female and 4% of adult male populations,[1] and close to 20% of the elderly population.[2] OSA results in excess daytime sleepiness and decreased health-related quality of life.[3]

Continuous positive airway pressure (CPAP) is an effective therapy for OSA, significantly reducing OSA symptoms in a vast majority of cases.[4] Successful application of CPAP can dramatically improve the health-related quality of life of patients and transform somnolent individuals into energetic and more productive people.[5] Moreover, the use of CPAP can decrease systemic BP and improve cardiovascular performance, thereby decreasing cardiovascular morbidity and mortality associated with OSA.[5]

However, CPAP therapy is often difficult to tolerate and patients frequently stop using it because of discomfort. The nasal mask interface may cause pressure sores, persistent air leakage, claustrophobia, nasal congestion, and other side effects that may lead to suboptimal compliance.[6] One study[7] suggests that CPAP compliance might be improved with intensive CPAP support, where these problems can be addressed through a multidisciplinary team approach. However, as these results were produced in a clinical trial setting, it remains uncertain whether high CPAP compliance rates can also be achieved in the community using a similar CPAP program.

Using data from a comprehensive CPAP program implemented in Northern Alberta (population 1.3 million persons) beginning in July of 1999, the aims of this study were to determine: (1) short-term and long-term CPAP compliance rates in the community, (2) baseline predictors for long-term CPAP compliance, and (3) whether CPAP use is associated with sustained improvements in daytime sleepiness in OSA patients with moderate-to-severe disease.

Methods and Materials

General Program Description

This study was conducted at the University of Alberta Hospital (UAH) Sleep Disorders Laboratory, in Edmonton, AB, which is the only accredited sleep facility to conduct supervised polysomnography in Northern Alberta. Funding for the CPAP devices were provided by the Alberta Aids to Daily Living, a government agency that oversees the provision of Respiratory Health Services and respiratory equipment to the citizens of Alberta. Funding was also provided for hiring a dedicated CPAP clinic nurse with the specific role of educating and following these patients on a regular basis.

Recruitment and Consent

Between July 1999 and March 2000, all patients undergoing diagnostic polysomnography at the UAH Sleep Disorders Laboratory were considered as potential recruits for this study. All patients were referred for clinical evaluation of possible sleep disorders.

Patients with an AHI ≥20/h were considered to be eligible candidates to receive a CPAP device provided by Alberta Aids to Daily Living without any cost to the patient. Some subjects with an AHI < 20/h also received CPAP therapy if there were significant clinical indications for CPAP therapy. All patients receiving CPAP devices were asked to sign a consent form indicating their willingness to comply with CPAP therapy, and their explicit understanding that the CPAP device must be returned if their compliance was deemed unsatisfactory, as measured through a pressure-sensing chip included in each CPAP unit.

Polysomnography

The diagnostic polysomnographic studies were performed at the UAH Sleep Disorders Laboratory. Recordings were performed overnight with continuous monitoring of EEG, electro-oculogram, chin electromyogram, oronasal airflow (by thermistor), chest and abdominal respiratory movements, oximetry, anterior tibialis electromyogram, body position sensor, and snoring noise sensor. Digitized signals were stored on optical disk and analyzed using software (Sandman Elite Version 5.0; Nellcor Puritan Bennett [Melville] Ltd., Ottawa, ON, Canada). Manual scoring was done by trained, certified technologist to verify the automated scoring system in every case. All sleep recordings were verified by American Board of Sleep Medicine-certified sleep specialists who provided descriptive diagnostic interpretation of the polysomnographic studies.

Scoring of sleep staging was done using published criteria.[8] An apnea episode was defined as a cessation of oronasal airflow for > 10 s. An hypopnea episode was defined as a diminution of the amplitude of respiratory signals by > 50% for > 10 s, with or without desaturation. An obstructive respiratory event was scored when there was evidence of paradoxical chest and abdomen movement. A central respiratory event was scored when both the chest and abdominal respiratory movements were diminished.

Follow-up Protocol
All CPAP subjects underwent an educational session prior to commencement of CPAP therapy, which included a 26-min video presentation (produced locally by the Sleep Apnea Society of Alberta) and a one-on-one discussion session with a qualified CPAP clinic nurse. The videotape presented information on OSA, including symptoms, health consequences, and pathophysiology, and a detailed explanation on the use of the CPAP device. The key concepts from this videotape was subsequently reinforced by a CPAP nurse who had prior training and experience in polysomnographic studies and in basic respiratory therapy principles relevant to the care of the CPAP devices. Reading materials were given to each subject, with a pamphlet on OSA, CPAP devices, suggestions for troubleshooting and remedies, as well as a follow-up schedule.

Subjects were instructed to contact the CPAP clinic nurse daily by telephone within the first week. Subsequently, the subjects were seen at 2 weeks, 4 weeks, 3 months, and 6 months after starting CPAP therapy. At each visit, the compliance data were downloaded from the CPAP device and reviewed by the CPAP clinic nurse together with the subjects. Any concerns or questions were addressed immediately by the CPAP clinic nurse, and changes in the CPAP setting, nose/face mask, or circuit were made after consultation with the responsible sleep physician if necessary. If nasal complaints were significant, either topical steroid spray or anticholinergic nasal spray was prescribed. If these failed, a heated humidifier was then made available. During the study period, only 15 patients required a heated humidifier. Each follow-up visit lasted 15 to 30 min.

The compliance data from each visit were tabulated and reported to the referring sleep physician. If there were doubts about a patient's compliance or willingness to continue with the program, the referring physician made personal contacts with the patient by telephone or through direct in-person interviews to resolve barriers to adequate compliance. Through a collaborative team effort, patient problems were addressed and resolved.

CPAP Device
The CPAP device used was the Aria LX model (Respironics; Pittsburgh, PA). There were various nose masks, face masks, nasal pillows, and head-harnesses used, depending on individual facial structure and preference. Passive humidifiers were routinely used. Heated humidifiers were used when necessary. In all CPAP devices, there was a built-in monitoring chip for collection and storage of CPAP usage data. The monitoring chip only registers use when the set pressure was maintained, not just when the CPAP device was turned on. The monitoring device provided time of days used, hours of daily use, and days used per month. From these data, we calculated: Percentage of days CPAP was used

$$= \frac{\text{No. of days when} \geq 1 \text{ h of use was recorded}}{\text{total No. of follow} - \text{up days}}$$

Mean daily use (hours)

$$= \frac{\text{total hours of CPAP used}}{\text{total No. of follow} - \text{up days}}$$

Mean daily use on days CPAP was used

$$= \frac{\text{total hours of CPAP used}}{\text{total No. of days when} > 1 \text{ h of use was recorded during follow} - \text{up}}$$

Measurements

At the start of the CPAP program, and during each follow-up visit, subjects were asked to complete a questionnaire regarding the degree of daytime sleepiness (the Epworth Sleepiness Scale [ESS]).[9]

Statistical Analysis

The means and SDs of continuous variables were compared using Student's two-tailed *t* test. Nonnormally distributed variables were compared using the Wilcoxon rank-sum test. Ordinal and binary variables were compared using a χ^2 test. A trend test was used to determine significance of temporal relationships in the use of CPAP over the 6 months of follow-up. To determine important predictors of 6-month compliance to CPAP, we used a multiple logistic regression model. We employed a step-wise regression model to select out significant variables; only those variables that produced a p value < 0.05 were included in the final model. Odds ratios are presented with 95% confidence intervals, and reported p values are two-tailed. All p values < 0.05 were considered statistically significant. All analyses were performed with statistical software (SAS release 8.1; SAS Institute; Cary, NC).

Results

Study Cohort

During the study period, 1,007 patients underwent diagnostic polysomnography for a suspected sleep disorder. Of these, 296 patients (29.4%) had an AHI ≥20/h and were invited to join the CPAP program. No patients refused, and all were followed up for the duration of the study period. We did not lose any patients during follow-up. The baseline demographic and sleep study features for patients with and without OSA are shown in Table 1 . Patients with OSA were slightly older, more obese, and more likely to be men than those without OSA. Moreover, OSA patients displayed increased fragmentation of sleep as evidenced by lower sleep efficiency and increased representation of stages 1 and 2 sleep than those without OSA. As expected, OSA patients had a higher AHI and lower mean arterial oxygen saturation (SaO_2) compared to those without OSA.

Compliance to CPAP Therapy for OSA Patients

The average CPAP setting at initiation was 11.6 ± 2.7 cm H_2O (mean ± SD). The average hours of CPAP use during the study period was well maintained; however, there was a slight decline in the total percentage of days that CPAP was used over the first 6 months of therapy.

Because there is no universally accepted definition of CPAP compliance, CPAP compliance was defined in multiple ways using mean hours of daily CPAP use. Even using a very stringent definition of CPAP compliance (*i.e.*, ≥4.5 h/d), 83% and 79% of the patients in this program were compliant with their CPAP therapy at 3 months and 6 months, respectively.

ESS

By 2 weeks of therapy, there was a dramatic decrease in the subjective feeling of sleepiness as measured by the ESS (44% relative reduction). The ESS scores at baseline, 2 weeks, 4 weeks, 3 months, and 6 months of therapy were 14.1 ± 5.6, 7.9 ± 5.3, 7.1 ± 4.7, 6.0 ± 4.5, and 5.5 ± 4.4, respectively. The test for trend (toward decreasing ESS scores with increased follow-up time) was significant ($p = 0.001$), suggesting an inverse monotonic relationship between elapsed time since the start of CPAP therapy (up to 6 months) and daytime sleepiness.

Predictors of CPAP Use

Using a step-wise approach, we determined the important clinical predictors of CPAP use at 6 months after CPAP initiation. In our initial model, we included changes in ESS score at 6 months compared to baseline, total sleep time, sleep efficiency, AHI, mean SaO_2 during sleep, gender, age, body mass index, periodic leg movement index, and various sleep stages, and correlated these variables to the mean hours of daily use of CPAP. In our final multiple regression model, only three variables were found to be significantly correlated with CPAP use: change in ESS scores ($p = 0.003$), gender ($p = 0.020$), and age ($p = 0.021$). There was a negative association between the magnitude of ESS score change and CPAP use, such that a 10-U decrease in ESS score was associated with a 0.76 ± 0.11-h increase in the amount of CPAP used per day of follow-up. Age, however, was positively associated with CPAP use; a 10-year increment in age was associated with 0.24 ± 0.11-h increase in CPAP use. Women, on average, used CPAP more frequently than men by 0.76 ± 0.32 h.

Discussion

This population-based CPAP program produced several interesting findings. First, we observed that > 92% of OSA patients in this program used CPAP for > 2.5 h/night on average for the first 6 months of the program. Even using a more stringent criterion for compliance (*i.e.*, ≥4 h of CPAP use per night), 84% of the eligible CPAP recipients were compliant with CPAP over the first 6 months of the program. Second, as expected, with the application of and compliance with CPAP therapy, there was a marked improvement in the patients' daytime sleepiness as measured by the ESS. In just 2 weeks following initiation of CPAP therapy, we observed a 44% relative reduction in the average daytime sleepiness for our cohort of patients. More importantly, this improvement was sustained for the duration of the 6-month follow-up period, suggesting that continued compliance with CPAP provides long-term benefits for patients with OSA. Third, women, older patients, and those who experienced marked improvements in their daytime sleepiness were more likely to be compliant with CPAP at 6 months than those without these parameters.

Several large studies[10] [11] [12] [13] have been previously published concerning CPAP compliance in the community, which have shown compliance rates ranging from 65 to 80%. Such a wide variation in the reported compliance rates may in part be related to the way in which compliance has been measured. For instance, McArdle and coworkers[14] reported a 6-month compliance rate of 85% using a program similar to ours. However, their definition of compliance was > 2 h/night of CPAP use.[14] Moreover, they used built-in counters on CPAP devices to capture utilization data; however, these devices tend to overestimate actual compliance as measured by pressure-actuated devices such as the one we used.[15] [16] In an earlier work, Kribbs and coworkers[15] used a microprocessor to measure "actual" compliance and reported an average duration of CPAP use of 4.9 ± 2.0 h (on days that CPAP was used) over a 3-month period. In our program, we observed an average duration of CPAP use of 6.2 ± 1.8 h over a similar time frame. In a more recent study, Pepin and coworkers[16] reported a 3-month compliance rate of 74% using criteria of > 4 h of use per day. Even using very stringent criteria for compliance in our study (≥ 4 h of use), we found that 87% and 84% of patients were compliant at 3 months and 6 months, respectively, suggesting our program was effective in securing adequate compliance in most OSA patients.

We believe that several factors were important in producing good CPAP compliance among our cohort of patients. First, we carefully selected patients with "objective" documentation of OSA (using an AHI of ≥20/h) for our program and systematically treated all of them with CPAP. Patients with an AHI < 20/h were enrolled on a case-by-case basis (data not included in this analysis). Second, we designed our program to maximize the compliance rate in our participants. We incorporated the elements that have been suggested by previous investigators[6] to be important for improving CPAP compliance over the long term.

These measures included intense patient education, use of a dedicated CPAP nurse to ensure close follow-up of patients (particularly during the first 2 weeks of therapy), troubleshooting when necessary, and rapid involvement of sleep physicians to solve compliance issues for difficult-to-manage patients. Third, we provided the CPAP device and ancillary services free of charge to the patients, removing significant financial concerns for patients.

Our findings that increasing age, female sex, and changes in ESS scores from baseline were associated with CPAP compliance are consistent with findings by McArdle and coworkers[14] but dissimilar to those from Janson and coworkers.[17] However, the latter study employed a case-control design (which is prone to more biases),[18] had smaller study sample, and, most importantly, used only oximetric results for OSA diagnosis, which may have led to a diagnostic misclassification.

The present study has certain limitations. First, while good CPAP compliance was achieved in a vast majority of OSA patients in our program, due to the nature of the study design, it remains uncertain which elements or components of the program were responsible for this success. Indeed, the uncontrolled protocol used in this study makes it difficult to attribute the excellent CPAP compliance rates directly to the comprehensive CPAP program. Nevertheless, the totality of evidence from our study, as well as those of others,[7] [15] suggests that high compliance rates to CPAP can be achieved in a environment that fosters patient education, comprehensive follow-up, and integrated care. Second, before we started the program, we decided collectively to use the criteria of an AHI ≥20/h as the treatment threshold. This decision is partly based on previous report of increased mortality in OSA subjects with an AHI ≥20/h who are untreated.[19] There is evidence that some patients with an AHI < 20/h may also benefit symptomatically from nasal CPAP, but the results are not definitive and it is not possible at the moment to clearly identify the subjects (with an AHI < 20/h) who might benefit. We do not wish to imply that OSA patients with an AHI < 20/h should not be treated. Our study did not include these subjects, and therefore we cannot report on the CPAP compliance rate in these subjects. Further studies will be necessary to determine the treatment threshold and compliance rate in OSA subjects with mild disease.

In summary, our study findings suggest that high CPAP compliance rates are achievable in the community through a comprehensive CPAP program that provided free CPAP devices, extensive education, and follow-up services for symptomatic OSA patients with moderate-to-severe disease through a multidisciplinary team approach. Future studies are needed to determine which of the components of the program are the critical pieces in effecting excellent long-term CPAP compliance rates in the community.

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Patient Compliance

Efforts to minimize the side effects of CPAP therapy should be made in order to enhance the quality of patients' lives and to increase the likelihood of good therapeutic compliance

Taj M. Jiva, MD

Nasal continuous positive airway pressure (nCPAP) therapy for obstructive sleep apnea (OSA) was first described in 1981 by Sullivan and colleagues.[1] Since then, CPAP is the treatment of choice for the majority of patients with OSA. Several mechanisms have been proposed to account for the benefit of nCPAP therapy such as the positive airway pressure acting as an "airway splint" and keeping the collapsible area of upper airway patent; nCPAP may maintain upper airway patency by a reflex mediated via the increase in end-expiratory lung volume. However, there is evidence against a reflex-mediated reduction in upper airway resistance.

NCPAP has been shown to depress electromyographic activity of the upper airway dilator muscles,[2,3] and lung volume dependence of pharyngeal cross-sectional area in patients with OSA has been reported.[4]

A direct relationship between lung volume and upper airway patency may be due to traction created on mediastinal and upper airway structures[5,6]; however, this effect plays a minor role in variation of upper airway resistance or patency with lung volume.[7] CPAP eliminates OSA whereas continuous negative extrathoracic pressure does not eliminate apnea with comparable augmentation of lung volume.[8] Hence, benefit of nCPAP is due to positive pharyngeal pressure.

NCPAP Compliance

After a CPAP titration study,[9] the initial acceptance rate by patients is 70% to 80%.

Most patients report a subjective sensation of well-being, decrease in daytime sleepiness, increased alertness, relief of morning headaches, decreased nocturnal awakenings, and decreased irritability. Reduced daytime sleepiness has been reported just after 1 night of nCPAP therapy.[10] Individuals who derive no subjective benefit from such a trial are poor candidates for home therapy with CPAP and are likely to exhibit lower compliance rates.[9] About 90% of OSA patients will adhere to long-term CPAP.[9] Patients abandoning CPAP do so during the first few months of therapy.[9] Lower acceptance and compliance rates have been reported in North America as compared to Europe.[9] The American Thoracic Society reported overall compliance rates of 50%.[11]

CPAP therapy is associated with some side effects related to the patient-device interface. These include skin abrasion or rash, conjunctivitis from air leak, and ulceration of the bridge of the nose[12]; sensation of high airflow or pressure, chest discomfort, aerophagia, sinus discomfort, smothering sensation, insomnia, rhinorrhea, nasal congestion or dryness, epistaxis, and, rarely, pneumothorax, pneumomediastinum, or pneumoencephalos[13-15]; the device is too cumbersome and inconvenient and interferes with the patient's lifestyle; spousal intolerance (one patient's wife said, "That machine has taken my husband away and I hate it"); and indefinite or lifetime use of CPAP.

Several studies have examined patient compliance with nCPAP therapy. Sullivan and coworkers[16] reported the initiation of nCPAP therapy on 35 of 50 patients with sleep apnea who had good compliance over a period of 3 to 30 months. Frith and Cant[17] found that 72% of patients used nCPAP from 3 to 22 months. Nino-Murcia et al[18] defined compliance as continued use of the device by 83% of patients. When compliance was defined as nightly or nearly nightly use, only 67% of patients were found to be compliant.[18] However, none of these studies evaluated the number of hours the device was used per night. Sanders et al [19] demonstrated that 85% of patients undergoing a trial of nCPAP in the sleep laboratory were satisfactory candidates for home therapy if there was amelioration of sleep-disordered breathing by the device and patient willingness to use the device on a long-term basis. They defined compliance as nightly use of CPAP and patients were deemed compliant if they did not sleep without CPAP therapy more than 1 hour per night; 75% of patients sent home on therapy were compliant over 10.3±8 months (mean ±SD) of follow-up.[19] Waldhorn et al[15] found that 85% of patients tolerated a laboratory trial of nCPAP and 76% of patients sent home to use the device were still using it after 14.5±10.7 months. These studies determined patient compliance through questionnaire or interview data. When we reviewed the studies that used objective data,

such as timers on the device to measure compliance, the mean duration of using the device was 5.1±2.6 hours per night and 40% of patients used the CPAP mask more than 6 hours per night.[20] Fletcher and Luckett[21] reported an average of 6 hours of CPAP use per night by patients.

Studies have suggested that compliance improves with increased severity of daytime sleepiness.[15] the frequency or side effects of CPAP including initial apnea-hypopnea index, gender, weight, or prescribed level of CPAP did not appear to discriminate compliant groups of patients from those who were noncompliant.[21]

In long-term studies, the most consistent correlation of the daily use of CPAP was with objective measures of OSA severity at the time of diagnosis including the apnea-hypopnea index, the movement arousal index reflecting sleep fragmentation, or oxygen-hemoglobin saturation during sleep.[9] In most studies, the multiple sleep latency test (MSLT) or scoring sleepiness at the time of diagnosis was not significantly correlated with the subsequent use of CPAP.[9] Patients with low compliance did not have higher pressure.[22]

Improving Therapeutic Compliance

• Minimizing Side Effects of NCPAP—Poor mask fit can be addressed by trying different sizes of commercially available masks or by having a mask custom made. Nasal dryness can be treated with saline nasal spray at bedtime, a room vaporizer, or warm humidification added to the CPAP system. Nasal steroid sprays or ipratropium bromide spray can help with rhinorrhea.[13,15] If a patient has chest discomfort or difficulty tolerating CPAP, bilevel positive airway pressure can help to reduce the expiratory pressure.[23]

• Nasal Prong System—This system is helpful in individuals suffering from claustrophobia, anxiety, or panic disorder.[9]

• Full Face Mask—Some individuals cannot tolerate nasal masks or prongs or are unable to keep their mouth closed during CPAP even with the use of a chin strap to permit adequate positive intrapharyngeal pressure. In such situations, using a full face mask should be considered. There is a potential risk of aspiration of gastric contents if the patient wearing a full face mask vomits. Patients should be instructed not to eat anything for at least 3 hours before applying the CPAP mask. Safety valves should be incorporated in the circuit close to the patient to facilitate inhalation of fresh air and to minimize dead space in the event of machine malfunction. An alarm must be present to signal power failure.

• Pressure Ramping—The pressure ramping feature of CPAP allows the adjustment of the rate of rise in delivered pressure over time from a negligible level to that required to maintain upper airway patency during sleep. This allows a window of opportunity for the patient initiating sleep. There are no published data available on the effectiveness of pressure ramping in improving patient compliance.[24]

• Therapeutic Use of Auto-CPAP—In an excellent review by Krieger,[24] the therapeutic use of auto-CPAP was addressed. The rationale of auto-CPAP is that requirements in mask pressure are not constant, but vary in a given patient depending on several factors including alcohol, use of drugs, body position during sleep, sleep state, and nasal permeability as influenced by weather or allergic conditions (short term).[24] The long-term factors include body weight, hormonal status, and sleep deprivation. This device, by adjusting instantaneously to the patient's needs, is expected to correct breathing abnormalities better than fixed pressure CPAP.[24] However, no published studies comparing the respiratory disturbance index (RDI) with auto-CPAP to RDI with fixed CPAP have demonstrated that the new technology was better than fixed CPAP in reducing RDI in short-term or long-term comparisons.[25] Auto-CPAP offers no benefit over fixed CPAP in terms of the apnea-hypopnea index or other outcomes, and there was no difference in compliance with treatment between auto-CPAP and fixed CPAP.[24]

Bilevel Positive Airway Pressure

When using CPAP, patients may experience a smothering sensation while exhaling against positive pressure, chest wall discomfort, or nasal or sinus pressure. There is a potential risk of barotraumas in individuals with bullous emphysema, and alveolar hypoventilation may occur with increased expiratory pressure. Hence, CPAP pressure may need to be reduced to a minimal effective pressure. Upper airway resistance has been shown to increase during expiration despite the absence of negative intrapharyngeal pressure.[26] Sanders and Kern[23] suggest that splinting positive pressure in the upper airway during inspiration and expiration is necessary to eliminate apneic events. They propose that less pressure would be required to maintain upper airway patency during expiration than during inspiration.[23] During expiration, inherent upper airway instability is the primary factor that favors upper airway collapse. CPAP provides equal pressure during inspiration and expiration.

With bilevel positive airway pressure, adjustment of inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure is possible. Sanders and Kern[23] believe that in patients with OSA, bilevel positive airway pressure can deliver a sufficient level to prevent upper airway collapse during expiration. IPAP would augment airway patency to eliminate partial obstructions (hypopneas) with hypoxemia or arousals from sleep. With bilevel positive airway pressure, patients can determine their own inspiratory flow and frequency, and maintain a more physiologic breathing pattern; inspiratory-expiratory pressure cycling can be achieved even in the presence of mild to moderate air leaks.[23] Patients find bilevel positive airway pressure to be more comfortable than CPAP (greater comfort associated with exhalation against lower pressure).[23]

Bilevel positive airway pressure is a therapeutic alternative for individuals who find CPAP uncomfortable or in individuals with severe bullous emphysema. Because average mask pressures are lower on bilevel positive airway pressure, air leakage, nasal congestion and rhinorrhea, chest discomfort, and risk of hypoventilation are reduced. However, it is not clear whether compliance with bilevel positive airway pressure is better than nCPAP. Bilevel positive airway pressure provides inspiratory pressure support

and can be used to provide nocturnal ventilatory assistance in patients with neuromuscular diseases or chest wall disorders and associated OSA.[23]

The built-in time counter of the CPAP machine measures the cumulative time that the apparatus is turned on (machine run time).[9] The time counter permits recognition of low rates of use. Here, early intervention helps to improve adherence and use of CPAP. Close follow-up can improve compliance.

In a randomized crossover study, patients with mild to moderate OSA were subjectively more satisfied with an oral appliance than with CPAP.

This was despite the fact that CPAP was objectively more effective at correcting snoring, OSA, and excessive daytime sleepiness.[27] Oral appliances are indicated for patients with moderate to severe OSA who are intolerant of or refuse treatment with nCPAP.[28] There is a move to combine oral appliances and CPAP in new products. One uses an appliance instead of a mask to hold the hose delivering the pressurized air through nasal pillows directly into the nares.[28] The aim is to eliminate the claustrophobia and air leaks associated with nCPAP (two common problems contributing to poor compliance). This combined device also eliminates the need for head gear to keep the mask in place. Another device delivers the pressured air directly into the oral cavity.[28]

Conclusion

The lack of subjective benefit from CPAP appears to be a major factor having detrimental influences on adherence and compliance.[9]

Every effort should be made to minimize the side effects of CPAP in order to enhance the quality of patients' lives and to increase the likelihood of compliance. In my practice, I find that the severity of sleep apnea is directly proportional to the symptomatic improvement and consequently to compliance. Patients with more severe OSA are expected to derive more benefit from CPAP, and this probably accounts for the association between indices of OSA severity and CPAP acceptance and use.[9]

Patients who have family members or friends using CPAP are more acceptable to this mode of therapy for sleep apnea. In my opinion, educating patients plays a large part in their compliance with CPAP. This entails having a display of various masks including nasal pillows for patients with claustrophobia, Epworth sleepiness scoring, videos on sleep apnea and CPAP therapy, and visiting Web sites about sleep disorders. I also discuss the long-term cardiovascular risk factors associated with sleep apnea if it is not treated; they include an increased risk of heart attacks, cardiac arrhythmias, congestive heart failure, and strokes. The risk of sleep-related accidents is also discussed including the risk of car accidents while falling asleep at the wheel, which is 15 times higher. This information is reviewed at each patient's appointment in the clinic for sleep disordered breathing. It is important that sleep specialists and the staff of the sleep center provide continuing educational resources and support for patients.

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Compliance with CPAP therapy in older men with obstructive sleep apnea.

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OBJECTIVES: Factors specifically affecting compliance with continuous positive airway pressure (CPAP) in older patients with obstructive sleep apnea (OSA) have not been described. The purpose of this study is to determine which factors are associated with compliance and noncompliance in older patients, a growing segment of the population. DESIGN: A retrospective chart review of older male patients prescribed CPAP therapy for OSA over an 8-year period. SETTING: Veterans Affairs Medical Center. PARTICIPANTS: All patients age 65 and older for whom CPAP therapy had been prescribed for treatment of OSA in the past 8 years. MEASUREMENTS: Records of all older male patients prescribed CPAP therapy for OSA over the last 8 years were reviewed.

Compliance was defined by time-counter readings averaging 5 or more hours of machine run-time per night. RESULTS: Of 33 older male patients with OSA studied, 20 were found to be compliant and 13 noncompliant with nasal CPAP therapy. The mean age (+/- SEM) at the time of diagnosis of OSA in the compliant group was 68 (+/-1) years, whereas that of the noncompliant group was 72 (+/-1) years (P <.05). Of the compliant patients, 95% attended a CPAP patient education and support group, whereas only 54% of noncompliant patients attended (P =.006). Resolution of initial symptoms of OSA with CPAP therapy was significantly associated with compliance. Symptom resolution occurred in 90% of compliant patients and in only 18% of noncompliant patients (P <.0002).
Factors that were significantly associated with noncompliance with CPAP were cigarette smoking, nocturia, and benign prostatic hypertrophy (BPH). Of noncompliant patients, 82% complained of nocturia, whereas only 33% of compliant patients complained of nocturia (P =.02). BPH was diagnosed in 62% of noncompliant patients and in only 15% of compliant patients (P =.004). Diuretic use was more common in the compliant group and, therefore, was not a cause of increased nocturia in noncompliant patients.
CONCLUSION: In older male patients with OSA, compliance with CPAP therapy is associated with attendance at a patient CPAP education and support group. Resolution of symptoms with therapy also appears to be associated with enhanced compliance. In addition, we found an association between nocturia and the existence of BPH in older men with OSA who are not compliant with nasal CPAP. Larger observational studies should be performed to confirm these findings, and, if so confirmed, then further studies to determine whether treatment of BPH in older men with OSA improves compliance with CPAP.

Effects of Augmented Continuous Positive Airway Pressure Education and Support on Compliance and Outcome in a Chinese Population[*]

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Abstract
Objectives: To study the effects of augmentation of continuous positive airway pressure (CPAP) education and support on compliance and outcome in patients with obstructive sleep apnea (OSA).

Design: A randomized, controlled, parallel study of basic vs augmented CPAP education and support.

Setting: A university teaching hospital.

Patients: A total of 108 OSA patients randomized into basic-support (BS) and augmented-support (AS) groups.

Interventions: Patients in the BS group (n = 54) were given educational brochures on OSA and CPAP, CPAP education by nurses, CPAP acclimatization, and were reviewed by physicians and nurses at weeks 4 and 12. Patients in the AS group (n = 54) received more education, including a videotape, telephone support by nurses, and early review at weeks 1 and 2.

Measurements: Objective CPAP compliance, Calgary sleep apnea quality of life index (SAQLI), and cognitive function after 1 month and 3 months; and Epworth sleepiness scale (ESS) after 3 months of CPAP treatment.

Results: At 4 weeks, CPAP usage was 5.3 ± 0.2 h/night (mean ± SEM) vs 5.5 ± 0.2 h/night in the BS and AS groups, respectively (p = 0.4). At 12 weeks, CPAP usage was 5.3 ± 0.3 h/night vs 5.3 ± 0.2 h/night in the two groups, respectively (p = 0.98). There was greater improvement of SAQLI at 4 weeks (p = 0.008) and at 12 weeks (p = 0.047) in the AS group. There was no significant difference between BS and AS groups in terms of improvement of ESS and cognitive function.

Conclusion: Augmentation of CPAP education and support does not increase CPAP compliance, but leads to a greater improvement of quality of life during the reinforced period.

Introduction

Obstructive sleep apnea (OSA) syndrome is a common disorder affecting 2 to 4% of middle-aged adults.[1] Excessive daytime sleepiness is a major consequence of OSA, due to sleep fragmentation triggered by repetitive episodes of partial or complete upper-airway obstruction.[2] Sleep fragmentation may also contribute to impaired cognition or altered mood,[3] and patients are prone to accidents at work or while driving,[4] with poor work and social functioning.[5]

Introduced by Sullivan et al[6] in 1981 as a pneumatic splint to prevent collapse of the upper airway, nasal continuous positive airway pressure (CPAP) has remained the standard treatment for OSA, and several randomized placebo-controlled trials have shown significant improvement of symptoms, quality of life, and daytime function in patients treated with nasal CPAP.[7] [8] [9] [10] [11] CPAP compliance, however, has been variable in different studies, ranging from 2.8 to 6.0 h/night in new CPAP users.[7] [8] [9] [10] [11] [12] [13] [14] In a prospective study of 23 newly diagnosed OSA patients commencing CPAP treatment, we previously reported an objective CPAP compliance rate of 64% and 67% at 1 month and 3 months, respectively,[15] with acceptable compliance as defined by Kribbs et al[12] as CPAP use of at least 4 h/d for at least 70% of the nights per week.

In this study, we would like to explore if augmentation of CPAP education and support within our resources would enhance CPAP compliance and improve treatment outcomes such as sleepiness, quality of life, and cognitive function among our OSA patients.

Materials and Methods

We performed a prospective, randomized, controlled, parallel study of basic vs augmented CPAP education and support on newly diagnosed OSA patients commencing nasal CPAP treatment.

Patients

From our respiratory and sleep clinic, we recruited 108 consecutive, symptomatic patients with newly diagnosed OSA. Significant OSA was defined as apnea-hypopnea index (AHI) ≥10 events/h of sleep as shown by overnight polysomnography (Sleep Lab 1000p; Aequitron Medical; Minnetonka, MN) plus self-reported sleepiness. Overnight polysomnography recorded EEG, electro-oculogram, submental electromyogram, bilateral anterior tibial electromyogram, ECG, chest and abdominal wall movement by inductance plethysmography, and airflow measured by a nasal pressure transducer (PTAF; Pro-Tech; Woodinville, WA), and backed up by oronasal airflow measured with a thermistor and finger pulse oximetry. Sleep stages were scored according to standard criteria by Rechtshaffen and Kales.[16]

Apnea was defined as cessation of airflow for > 10 s, and hypopnea was defined as a reduction of airflow ≥50% for > 10 s plus an oxygen desaturation of > 4% or an arousal. The subjects were randomized into two arms, with group 1 receiving basic CPAP education and support and group 2 receiving augmented education and support. Our study was approved by the Ethics Committee of the Chinese University of Hong Kong, and appropriate informed consent was obtained from the subjects.

Study Protocols

Basic Support:

Following confirmation of significant OSA from the overnight diagnostic sleep study, each patient was interviewed by the physician on duty and offered a trial of nasal CPAP treatment. Each patient was given a 10-min CPAP education program by a respiratory nurse who explained the basic operation and care of the CPAP device and mask. An brochure on OSA and CPAP treatment in Chinese was given to each patient during the education session. The nurse chose a comfortable CPAP mask from a wide range of selections for the patient, who was then given a short trial of CPAP therapy with the AutoSet (Resmed; Sydney, Australia) CPAP device for approximately 30 min of acclimatization in the afternoon. Attended CPAP titration was performed with the AutoSet auto-titrating device on the second night of the study in our hospital, with full polysomnography.

Throughout the night and the next morning, the nurses on duty would deal with any discomfort related to the CPAP treatment. The CPAP pressure for each patient was set at the minimum pressure needed to abolish snoring, obstructive respiratory events, and airflow limitation for 95% of the night, as determined by the overnight AutoSet CPAP titration study. Several studies have shown that automatic CPAP titration is as effective as manual titration in correcting the obstructive respiratory events, arousal frequency, and improving oxygenation.[17] [18] [19] [20] All the patients were prescribed the Aria CPAP device

(Respironics; Murrysville, PA), which automatically turned on when the patients breathed into the mask and shut off when the mask was removed.

The Aria CPAP contains a microprocessor with dual time meters recording both machine run time and time spent at effective pressure (measured by a mask pressure transducer recorder). The patients subsequently were followed up by physicians and nurses at the CPAP clinic at 1 month and 3 months to deal with any problem with the CPAP device or mask fit, and CPAP pressure was adjusted if necessary.

Augmented Support:
In addition to the basic-support (BS) group, patients in the augmented-support (AS) group were given extra education on OSA and CPAP by physicians via a locally produced 15-min videotape. Our respiratory nurses would also reinforce knowledge about OSA and provide solutions for potential problems with the use of CPAP during an additional 15-min education session. The patients were reviewed early by physicians at week 1 and week 2. The respiratory nurses also followed up these patients by phone on day 1 and day 2, and at weeks 1, 2, 3, 4, 8, and 12 to help sort out any technical problem and encourage the use of CPAP.

Outcome Measurements
Prior to commencement of nasal CPAP, all patients had to go through several measurements. These included assessment of subjective sleepiness with the Epworth sleepiness scale (ESS), quality of life with the Calgary sleep apnea quality of life index (SAQLI), and psychometric tests.

The ESS[21] is a questionnaire specific to symptoms of daytime sleepiness, and patients are asked to score the likelihood of falling asleep in eight different situations with different levels of stimulation, adding up to a total score of 0 to 24. The ESS has been shown to have significant correlation with the Multiple Sleep Latency Test, an objective measure of sleepiness.[22]

The Calgary SAQLI has 35 questions organized into four domains: daily functioning, social interactions, emotional functioning, and symptoms, with a fifth domain, treatment-related symptoms, to record the possible negative impacts of treatment. The SAQLI has a high degree of internal consistency, face validity as judged by content experts and patients, and construct validity as shown by its positive correlations with the Short Form-36 Health Survey questionnaire and the improvement in scores in patients successfully completing a 4-week trial of CPAP. It contains items shown to be important to patients with sleep apnea, and it is designed as a measure of outcome in sleep apnea clinical trials.[23] Scoring of the SAQLI was based on the manual by Flemons and Reimer.[24]

Cognitive function tests, including trail-making, digit-symbol, digit-span, and Stroop color testing, were performed to provide objective evidence for improvement in daytime function on CPAP treatment, as reported by Engleman et al.[7 8 9 10] The trail-making test estimated the minimum time required to connect a structured number sequence; the lower the score, the better the performance. The digit-symbol and digit-span tests involved the

immediate memory and recall of number sequences, while the Stroop color test evaluated the correct matching of colors and their corresponding characters. For the Stroop color, digit-symbol, and digit-span tests, a higher score indicated superior performance.

With the exception of the ESS, which was repeated at 3 months, all other baseline measurements were repeated at 1 month and 3 months. During the CPAP clinic follow-up, our patients were asked to report subjectively the amount of time they used the CPAP device per day and any problem associated with the use of CPAP.

The objective CPAP compliance was measured at 1 month and 3 months, with the Aria CPAP data downloaded into a personal computer using the Respironics Encore software (Respironics). The time spent at effective pressure was recorded as the objective compliance.

Statistical Analysis

Data were analyzed on an intention-to-treat basis. For comparison between basic and augmented education groups at each time point, an unpaired *t* test was used for normally distributed variables, and the Mann-Whitney test was used for nonnormally distributed variables. The improvement of variables from baseline was tested by paired *t* test.

Results

One hundred eight patients (11 female patients) entered the study and underwent baseline assessment. The mean age was 45 ± 11 years (mean ± SD); body mass index, 30 ± 8 kg/m^2; and AHI, 48 ± 24. There were slight but significant differences between the two groups in ESS and trail B. Otherwise, there was no statistically significant difference in other baseline outcome measures. All the patients returned for follow-up, but there was a technical problem with the Aria/Encore software, resulting in missing CPAP compliance data for 11 of the 108 patients (2 in the BS group and 9 in the AS group) at 3 months. Except for 17 socially disadvantaged patients (7 BS patients and 10 AS patients) who were eligible for government support, all of the others had to purchase or rent their CPAP units through a local distributor. Other results are reported as mean ± SEM.

CPAP Levels

The CPAP levels at baseline were 9.5 ± 0.2 cm H_2O and 11.1 ± 0.3 cm H_2O for the BS and AS groups, respectively. At 4 weeks, an equal number of patients in each group (9 of 54 patients; 16.7%) required adjustment of pressures, and the adjusted pressures became 9.3 ± 0.2 cm H_2O and 10.9 ± 0.3 cm H_2O for the BS and AS groups, respectively. At 12 weeks, 5 of 54 patients (9.3%) and 6 of 54 patients (11.1%) in the BS and AS groups required adjustment, and the adjusted pressures became 9.2 ± 0.3 cm H_2O and 10.4 ± 0.3 cm H_2O, respectively.

Compliance

There was no significant difference between the two groups in terms of objective CPAP usage and compliance rates. At 4 weeks, the CPAP usage was 5.3 ± 0.2 h/night vs 5.5 ±

0.2 h/night ($p = 0.4$), while at 12 weeks, the CPAP usage was 5.3 ± 0.3 h/night vs 5.3 ± 0.2 h/night ($p = 0.98$) in the BS and AS groups, respectively. The compliance rates were 71% at both 4 weeks and 12 weeks in the BS group, while those of the AS group were 79% and 74%, respectively. At both 4 weeks and 12 weeks, patients in both groups overestimated the actual amount of time they used CPAP, with the self-reported compliance much higher than the objective compliance in both groups ($p < 0.001$;).

Sleepiness

There was significant improvement of ESS in both the BS group and the AS group at 12 weeks, with the mean baseline ESS falling by 7.4 ± 0.8 and 8.1 ± 0.8, respectively, with $p < 0.001$ in both groups. However, there was no significant difference for the degree of improvement between the two groups, with $p = 0.6$.

Quality of Life

There was significant improvement of the Calgary SAQLI within both groups, with $p = 0.01$ and $p = 0.001$ at 4 weeks and 12 weeks, respectively, for the BS group, and $p < 0.01$ at both 4 weeks and 12 weeks for the AS group. There was no significant difference between the two groups with regard to daily functioning, social interaction, and emotional functioning. There was greater improvement of symptoms at 12 weeks in the AS group ($p = 0.03$), while there was no significant difference at 4 weeks. In terms of treatment-related symptoms from the CPAP treatment, there were no significant differences between the two groups. Overall, there was greater improvement of quality of life in the AS group at 4 weeks and 12 weeks, with $p = 0.008$ and $p = 0.047$, respectively.

Cognitive Function

There was greater improvement in digit span in the AS group at 4 weeks, with $p = 0.049$. However, this effect became insignificant at 12 weeks. None of the other cognitive function outcome variables showed any significant difference between the two groups at week 4 and week 12.

Discussion

Nasal CPAP has remained the standard treatment for OSA since it was first introduced almost 2 decades ago.[6] Several randomized, placebo-controlled trials have shown significant improvement of symptoms, quality of life, and daytime function in patients treated with nasal CPAP.[7 8 9 10 11] However, nasal CPAP is a rather obtrusive and cumbersome therapy, and compliance has been variable in different studies, ranging from 2.8 to 6.0 h/night in new CPAP users.[7 8 9 10 11 12 13 14]

Several studies have been published examining ways to facilitate CPAP compliance. Fletcher and Luckett,[14] in a prospective, randomized crossover study, examined the effect of weekly (thrice) and then monthly (twice) positive reinforcement via telephone support

on hourly compliance of 10 new CPAP users for 3 months vs no reinforcement for 3 months. Their study suggested that positive reinforcement by telephone did not favorably alter compliance. However, as half of their patients had already received telephone support during the reinforced period, it was difficult to determine the effects of reinforcement, as there was likely a carrying-over effect of such support in the nonreinforced period.

In a randomized controlled trial involving 33 subjects of two interventions to improve compliance, Chervin et al[25]

showed that telephone support or educational literature might improve self-reported CPAP usage, but their result fell short of statistical significance ($p = 0.059$). In a retrospective and nonrandomized study of 73 patients in an outpatient clinic, Likar et al[26] showed that group education sessions could improve compliance with CPAP therapy. More recently, in a prospective study of 80 consecutive new patients with OSA, randomized to receive usual support or additional nursing input (including CPAP education at home and involving their partners, a 3-night trial of CPAP titration in a sleep center, followed by additional home visits), Hoy et al[27] reported that there was greater improvement of objective CPAP compliance, OSA symptoms, mood, and reaction time in the intensively supported group at 6 months. However, such an intensive approach, which involves 2 extra nights of CPAP titration and additional nursing staff to provide home visits, is rather costly and may not be feasible or cost-effective in most sleep disorder centers with preexisting long queues for sleep studies.

Despite supplementing the education session with a 15-min videotape, a longer CPAP education session by nurses, telephone support in the first 3 months, and early follow-up, CPAP compliance was not significantly increased among our new CPAP users in the AS group. As there was no significant difference between the two groups in terms of CPAP usage, it was not surprising that, apart from a greater improvement of digit span of marginal statistical significance ($p = 0.049$) at 4 weeks in the AS group, there was no significant difference in improvement of other cognitive function outcome variables at 4 weeks, and subsequent reassessment of cognitive function and ESS at 12 weeks.

The AS group reported greater improvement of quality of life at 4 weeks and 12 weeks ($p = 0.008$ and $p = 0.047$, respectively), and this was likely related to the psychological support and attention given to the patients by our nurses via telephone daily for the first 2 days, weekly for the first 4 weeks, and monthly for the subsequent 2 months, together with the weekly review by physicians in the first 2 weeks immediately after commencement of CPAP therapy.

The lack of significant improvement in CPAP compliance in the AS group might be due to the fact that our BS program was highly adequate and the additional measures did not confer any extra benefit. Indeed, overall, 71% of our patients in the BS group used their CPAP for at least 4 h/d, and at least 70% of the nights per week at 4 weeks and 12 weeks.

The compliance rate was slightly lower than the 79% reported by Pepin et al[28] in a prospective, multicentre, European study, but much higher than that of 46% reported by Kribbs et al[12] in an American population. Our BS program consisted of educational brochures on OSA and CPAP, practical CPAP education, and acclimatization sessions conducted by our nurses, plus early CPAP clinic review at 4 weeks; these are all essential elements ensuring good CPAP compliance.

The mean CPAP usage in the BS group of this study was more than the 3.9 h/night reported by Hoy et al[27] in their control group at 6 months.

Apart from different patient populations, the major difference between their protocol and ours is the inclusion of educational brochures in our study. In addition, most of our patients had to purchase or rent the CPAP units themselves, and this factor may have increased the motivation of our patients. Our compliance results support the findings by Kribbs et al,[12] that the degree of compliance established within the first month of treatment with CPAP reliably predicts compliance at 3 months. Moreover, self-reported compliance, which was overestimated by our patients as in other studies,[12 13 29] should not be considered a reliable means to establish compliance.

There were several limitations in our study. Despite the randomization process, there were some differences in the baseline ESS score and trail B between the two groups. Hence, analysis was based on comparison of changes from baseline for the variables between the two groups. Apart from the CPAP usage measured by the Respironics Aria and Encore software and cognitive function tests, all other outcome variables such as ESS and SAQLI were subjective rather than objective measurements. There was also a technical failure with the Aria/Encore software, resulting in missing CPAP compliance data for two patients in the BS group and nine patients in the AS group at 12 weeks. Until there is breakthrough in the treatment of sleep-disordered breathing, CPAP remains a life-long therapy for most patients with OSA, but the results reported in this study were only up to 3 months of therapy.

However, there is evidence from a large follow-up study that the average nightly CPAP use within the first 3 months is strongly predictive of long-term use.[30] As an additional criticism of this study, automatic CPAP titration may not be regarded as standard practice by every sleep laboratory. However, the significant improvement of ESS at 12 weeks and SAQLI at 4 weeks and 12 weeks in both groups reassured us that the attended automatic CPAP titration had been effective. Automatic CPAP titration does not reduce the use[19] or acceptance[20] of CPAP compared with manual titration. The subsequent reduction in CPAP requirement in our patients has also been observed even with manual titration by Jokic et al[31] within 2 weeks of starting CPAP treatment, and this was likely to be due to resolution of upper-airway edema.[32]

In summary, this randomized controlled study shows that augmentation of CPAP education and support does not improve CPAP usage at 1 month and 3 months following commencement of CPAP treatment, but leads to a greater improvement of quality of life during the reinforced period. Nevertheless good basic education and support are essential

in ensuring good CPAP compliance, and this is reflected by the high level of CPAP compliance in our patient population.

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Can patients with obstructive sleep apnea titrate their own continuous positive airway pressure?

Fitzpatrick, Michael F

Manual continuous positive airway pressure (CPAP) titration in a sleep laboratory is costly and limits access for diagnostic studies. Many factors affect CPAP compliance, but education and support, rather than in-laboratory CPAP titration, appear to be pivotal. Self-- adjustment of CPAP at home will provide equal or superior efficacy in the treatment of obstructive sleep apnea (OSA) as compared with in-laboratory titration.

A randomized, single-blind, two-period crossover trial of CPAP treatment at the in-laboratory-determined optimal pressure versus at-home self-adjustment of CPAP (starting pressure based on prediction equation). Eighteen CPAP-naive patients (16 males, 50 +/- 15 years old, apnea hypopnea index 40 +/20) with a new diagnosis of OSA were tested. Testing was performed before and after CPAP treatment in each of two 5-week study limbs. CPAP, compliance with CPAP treatment, the Sleep Apnea Quality of Life Index, the Functional Outcomes of Sleep Questionnaire score, the Epworth sleepiness scale score, sleep architecture, sleep apnea severity, and maintenance of wakefulness tests were performed. Both modes of CPAP treatment significantly improved objective and subjective measures of OSA, but they did not differ in efficacy. Home self-titration of CPAP is as effective as in-laboratory manual titration in the management of patients with OSA.

Obstructive sleep apnea (OSA) is a common condition, affecting 4% adult males and 2% adult females (1). It is associated with significant mortality and morbidity, and untreated OSA imposes a substantial healthcare burden on the economy (2). Since its original description in 1981 (3), continuous positive airway pressure (CPAP) has become the standard treatment for OSA. It is a particularly effective treatment for patients with moderate or severe OSA (4) but

also has demonstrable benefits in patients with mild OSA (5, 6). CPAP titration to discern the optimal pressure required to alleviate upper airway obstruction during sleep usually includes a simultaneous recording of sleep, respiration, and oxygen saturation (7) and is typically conducted in a sleep laboratory.

This practice is expensive (two overnight sleep laboratory studies per patient with OSA-diagnostic and CPAP titration) and limits access to the sleep laboratory for diagnostic studies. Recent evidence suggests that the use of automated CPAP devices (8) and abbreviated CPAP titrations (9) can improve the efficiency with which CPAP treatment is delivered, as compared with conventional in-laboratory overnight CPAP titration. Given the high disease prevalence and limited healthcare resources, carefully evaluated attempts at greater efficiency in managing patients with OSA are needed. Approximately 15% of patients with OSA refuse CPAP treatment at the outset (10, 11), and compliance among those who accept this treatment is frequently suboptimal (12, 13). More intensive education and support have been documented to improve clinical outcomes in patients with OSA (14), and provision of an abbreviated care regimen resulted in an inferior clinical outcome (15). It is therefore essential to document both compliance with treatment and clinical outcomes in association with any intervention aimed at improving the efficiency with which treatment is delivered to patients with OSA.

An educational model in which the patient is empowered with the understanding and ability to make decisions regarding treatment has been demonstrated to be successful in other medical conditions (16). We reasoned that a similar educational approach might be successful in patients with OSA who require CPAP treatment.

Although the level of educational support, disease severity, treatment response, and other factors have been identified as contributors to CPAP compliance (17, 18), each has accounted for only a small part of the variance in compliance among individuals. The latter fact and the unpredictability of CPAP compliance among patients with OSA have led to the belief that the individual patient's outlook on CPAP treatment may be of paramount importance in determining CPAP compliance (17, 19), which may seem intuitively obvious, given the somewhat cumbersome nature of the device.

We therefore designed an intraindividual crossover trial to compare outcomes between the conventional in-laboratory method of CPAP titration and patient self-titration of CPAP for OSA.

METHODS

Design

A randomized, single-blind, two-period crossover design was employed, with a 1-week wash-in period off CPAP, two 5-week treatment limbs, and a 1-week washout between treatment limbs (Figure 1). On the "fixed limb," patients received CPAP at the pressure predetermined by manual in-laboratory titration and were not permitted to adjust the CPAP. On the "self-adjusting" limb, patients received CPAP preset at an estimated therapeutic pressure based on a prediction formula (20) and were encouraged to adjust the pressure as necessary to maximize comfort and perceived efficacy. Upon entry, patients underwent manual in-laboratory CPAP titration by an experienced registered polysomnographic technologist during full overnight polysomnography but were not informed of the optimal CPAP derived from that study. Pretreatment measurements in each limb were made to facilitate measurement of change in outcomes within each limb and to confirm a comparable degree of disease severity before treatment between limbs.

The study was approved by the Research Ethics Board at Queen's University, and written informed consent was obtained before entry.

Blinding Procedure

The pressure display on the CPAP unit was concealed throughout the fixed limb of the study with tape and adhesive that could not be removed by the patient. Sleep studies were scored blind by using a montage that excluded the CPAP signal.

Patient Education

A technologist provided 30-minutes of instruction on CPAP treatment for OSA, facial/nasal CPAP appliances, and symptoms that would suggest an incorrect CPAP setting before randomization. Patients were shown how to adjust the CPAP before the self-adjusting CPAP treatment limb.

Outcome Measures

CPAP compliance (mean hours/night), CPAP employed (cm HZO), Apnea Hypopnea Index (AHI) (21), objective sleep architecture, Epworth Sleepiness Scale Score (22), Sleep Apnea Quality of Life Index score (23), Functional Outcomes of Sleep Questionnaire (FOSQ) score (24), Maintenance of Wakefulness Test (40-minute version) mean sleep onset latency (25), and Trail Making B times) (26).

Compliance

Each CPAP unit (Aria; Respironics Inc., Pittsburgh, PA) recorded runtime, time at prescribed pressure, and the CPAP setting daily. The actual CPAP output was measured independently after each limb.

Taking a Bite Out of SDB

Treatment options such as oral appliance and CPAP therapies are keeping SDB at bay.

By Joseph R. Zelk, MS, FNP, BC

The specialty of sleep disorders medicine, recognized officially by the American Medical Association in 1996, has continued to grow tremendously. Many sleep disorders that were recently unfamiliar are now known as common terms in the average household. The specialty has been revolutionized by new procedures, diagnostic technologies, and treatments. Equally, advances are occurring at an unprecedented rate into the 21st century because of the continued improvements in comfort measures research, reliability of instrumentation, delivery of therapy, and responding to patient concerns as practitioners.

Inherent in the youth of this specialty are the seemingly diminutive steps of innovation that result in significant impact. In no area of this specialty is this more evident than in the treatment of sleep-disordered breathing. An example of this is the application of valuable compliance programs for CPAP. There is no debate that CPAP therapy has changed the landscape of modern medicine. The art of patient education, coupled with innovations in delivery of treatment, more varied options for treatment, and combinations of alternative treatment modalities, continues to improve patient acceptance and adherence to prescribed interventions.

CPAP Compliance

In many research articles, it is commonly reported that long-term compliance for sleep apnea patients nationally averages 50% to 60%.[1] Higher compliance is seen by integrating sleep diagnostic centers and durable medical equipment dispensing services that include comprehensive CPAP support, such as is done at Sleep Health and Wellness NW in Portland, Ore, where reported compliance rates approach 94%.

Despite this advancement, there remains a segment of the patient population that historically does not tolerate CPAP therapy well. Patients with mild and moderate sleep apnea are one vulnerable population. Other persisting factors that contribute to the resistant patient population in relation to long-term compliance are: lack of improvement in daytime functioning as a reinforcing drive for long-term use, severe OSA sufferers without excessive daytime sleepiness (EDS), high treatment pressures, mouth leaks, persistent pressure sores, persistent nasal congestion, epistaxis, rhinorrhea, complaints of

dry mouth, aerophagia, chest discomfort, sinus discomfort, claustrophobia, and bed partner intolerance.[1-8]

It is well documented that targeting each of these complaints individually will lead to CPAP therapy success. Those measures include CPAP mask desensitization; new and more compact, travel-friendly CPAP units that are not so obtrusive and cumbersome; heated humidification; medically treating nasal anatomic obstruction; as well as surgical options.

Instituting ramping times and trialing auto-titrating CPAP and bilevel PAP for patients with complex comorbidities and uncomfortably high treatment pressures are useful as well. It is clearly supported that consistent and frequent follow-up from the medical provider for this patient population does have a clear positive impact on long-term use.[2]

Follow-up for patient adherence and acceptance is a team effort. By having strong medical leadership and a well-trained allied health care team available to teach CPAP adaptation, many of the barriers to preventive therapy such as CPAP can be successfully removed. Other attributes include practice sessions for CPAP use, acclimation to the mask only, and wearing the unit on ramp pressures while napping or for short sedentary periods. Short-term institution of hypnotics is an effective adjunct for desensitization for the 2- to 4-week critical period of fragmented sleep due to the novelty of the therapy. Of course, addressing specific complaints is paramount. This should be combined with cognitive therapy to address misconceptions about one's sleep state and to educate the patient on the benefits of treating SDB. Review of consequences attributable to untreated OSA is effective as well.[2] All this said, if patients feel their quality of life is severely impacted, none of these measures are likely to be effective.[9-11]

Alternative Options

This introduction leads me to the objective of this article: interventions will not be accepted by the patient unless adequate review of alternative options is performed. The review of optional treatments should include the pros and cons, limitations in efficacy, or possible lack of certainty regarding outcomes of treatment. Lastly, easy access to and availability of specialist referrals are needed. Here at Sleep Health and Wellness NW, we have strategically aligned our group of sleep disorder centers with board-certified sleep specialists in a diverse range of primary specialties. Those include an otolaryngologist, pulmonologist, and neurologist who are all certified by the American Board of Sleep Medicine. Within this network, the close collaboration and convenient access to a specialist, such as a mid-level provider that is on-site, can quickly clarify appropriate treatment for the patient, and have been a tremendous advantage in expediting treatment.

In our network, we have a dentist who is a member of the Academy of Dental Sleep Medicine. He is readily available to consult on oral appliance therapy for OSA, and is also applying hybridized CPAP and mandibular advancement oral appliances. Our dental sleep specialist and medical sleep specialists confer regularly, which keeps the network up-to-date in both specialty arenas.

There is a large sector of the medical sleep community that is not readily accepting of the dental appliance option for patients who are intolerant to CPAP. Much of this can be readily attributed to the vast array of dental appliances in the market; the last count of FDA-approved medical devices was around 707. The more influential factor, likely, is the dearth of dental sleep board-certified practitioners available to each local sleep laboratory or center. One ground-breaking measure in this arena is the active collaboration of sleep disorder medical directors and local or regional board-certified dental sleep specialists.

By acting in this manner, these pioneering sleep communities are breaking down misconceptions, driving collaborative efforts, improving CPAP and oral appliance success rates, and innovating hybridized therapies.

A Collaborated Effort

In communities where this sort of collaboration is performed, the barriers to insurance coverage are quickly eroding secondary to combined efforts. Options for successful treatment of patients with SDB are exponentially more varied, and the speed of diagnosis to final successful treatment application is drastically accelerated. In our network, many patients who would have been lost due to excessive treatment pressures have been maintained and referred early in the process for oral appliance and CPAP therapy, resulting in decrements of pressure often as low as 75% of initial titration pressures. This frequently is achieved without advancing the mandible and simply maintaining the rest position of the mandible, thereby restricting mandibular range of motion and eliminating genioglossus prolapse.[5]

Other combinations available to our patients are oral appliance therapy (OAT) with directed palatal surgery; palatal pillars (theoretically); and phase II surgeries.[12,13] Not to forget conservative treatments that include weight loss, avoidance of sedatives and alcohol, positional therapy, and medical therapy or surgical intervention for nasopharyngeal obstruction.[3] Lastly, we offer in-office application of temporary OAT for patients who are concerned about possible suboptimal response to OAT. This is a cost-effective adjunct for those patients with mild to moderate OSA who are unwilling or unable to travel with their CPAP units or may want a trial on an inexpensive OAT before pursuing more permanent devices.

One action that has significantly impacted our understanding of OAT has been the in-servicing of the Academy of Dental Sleep Medicine practice parameters for the effective application of OAT with our network providers. This has resulted in higher statistical compliance with treatment for OSA and greater patient satisfaction due to a more complete and thorough understanding of the treatment options available.

Standards of Care for an OAT Referral Process

Our dentist with training in OAT is familiar with the various designs of appliances. He can determine which one is best suited for the patient's specific needs. Our dentist works closely with our providers as part of the medical team in diagnosis, treatment, and ongoing care. Determination of proper therapy is made by joint consultation of our

dentist and providers. Initiation of OAT can take from several weeks to several months to complete. Our dentist continues to monitor treatment and evaluate the response of the patient's teeth and jaws. He actively updates and refers the patients back for medical follow-up as clinically indicated.

Standards for treatment are:

- Patients with primary snoring or mild OSA who do not respond to, or are not appropriate candidates for, treatment with behavioral measures such as weight loss or sleep-position change.
- Patients with moderate to severe OSA should have an initial trial of nasal CPAP, due to greater effectiveness with the use of oral appliances.
- Patients with moderate to severe OSA who are intolerant of or refuse treatment with nasal CPAP. Oral appliances are also indicated for patients who refuse treatment or are not candidates for tonsillectomy and adenoidectomy, craniofacial operations, or tracheostomy.[14]

Ongoing care, including short- and long-term follow-up, is an essential step in the treatment of SDB with OAT. Follow-up care serves to assess the treatment of the SDB, the condition of the appliance, and patient response to OAT, and to ensure its comfort and effectiveness.

Advantages of OAT
OAT has several advantages over other forms of therapy including:

- Oral appliances are comfortable and easy to wear. Most people find that it takes only a couple of weeks to become acclimated to wearing the appliance.
- Oral appliances are small and convenient, making them easy to carry when traveling.
- Treatment with oral appliances is reversible and noninvasive.[14]

Side Effects of OAT
Our patients who decide to combine or simply undertake OAT are well aware of the potential side effects, which include, but are not limited to:

- tooth discomfort
- jaw or gum discomfort
- excessive salivation
- TMJ pain or dysfunction
- loosening of teeth
- tooth-position change
- jaw-position change

- space opening between the posterior teeth.[8,9]

Many of these symptoms are amenable to daily exercises, which may include the use of a leaf gauge or, at the polar end of management, orthodontic therapy. These potential side effects can be monitored by the patient's primary dentist.

Case Study

In September 2002, a 42-year-old female patient came in for a sleep test via polysomnography (PSG). She was snoring and had frequent nighttime awakenings. She had undergone septoplasty in July 2002. Her height was 66 inches, she weighed 265 pounds and had a body mass index (BMI) of 41.5, and her neck circumference was 45 cm. A Beck depression scale score of 8 and Epworth Sleepiness Scale (ESS) of 21/24 were obtained. The ESS score was consistent with pathologic somnolence. She was not hypertensive, and her medications were limited to fluticasone propionate nasal inhaler/spray and fexofenadine for seasonal allergies. Her chief complaint was severe daytime somnolence and unsafe driving in the morning to work. The diagnostic portion of the PSG revealed "severe OSA with an oxyhemoglobin saturation nadir of 74%." Her AHI was 99.7 with the longest event at 49.3 seconds (a follow-up home study showed excellent agreement).

The CPAP titration was successful, resulting in objective measurement of improved control of SDB and improved sleep architecture. The patient soon began to fail CPAP therapy despite close follow-up. She would remove the mask unconsciously and, despite months of effort, was unable to maintain compliance with treatment goals.

She was referred back to an ENT surgeon who evaluated and scheduled the patient for uvulopalatopharyngoplasty (UPPP) and adenotonsillectomy. Her oral airway was a Mallampati Class 2. The patient subsequently heard of the orthotic management of OSA and sought consultation regarding this option prior to the surgery date. After collaboration between the ENT surgeon and Rich Moore, DDS, a trial of OAT was agreed on to assess possible response prior to surgical intervention.

The OAT titration took place over a period of several months, utilizing patient symptom profile assessment, home study evaluation, and gradual mandibular advancement to achieve optimal results. The RDI was reduced to 8.7 with an oxyhemoglobin saturation nadir of 89% for a total of less than 1% of total sleep time.

According to Moore, this response is not that unusual. He reports great successes with severe OSA patients with varied baseline physical findings. He does clarify that there is increased variability in effect and higher grades of OSA severity, which is consistent with the literature.

It is evident that the management of patients with SDB will continue to have a multitude of options. The network of multiple specialists helps to drive patient satisfaction and success in their preventive efforts.

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The Results of CPAP therapy under two adherence schedules

Studies show that the use of CPAP for the entire sleep period is likely to be critical to the normalization of MSLT scores.

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It has been estimated that approximately 2% to 4% of adults are affected by obstructive sleep apnea (OSA).[1,2] Most patients are prompted to seek medical consultation because of loud snoring, stopped-breathing episodes during sleeping, and/or excessive daytime somnolence (EDS). For example, in a recent study[3] of consecutive patients evaluated for OSA, it was found that 25% of patients had chief complaints of loud snoring, 42% complained of stopped-breathing episodes, and 31% had complaints of EDS.

The degree to which patients' complaints are reversed by a therapeutic intervention may predict patient satisfaction and treatment compliance. In this context, treatment of OSA with continuous positive airway pressure (CPAP) has been somewhat controversial. Many studies have documented that patients use CPAP for only part of the night. Engleman et al[4] found no improvement on multiple sleep-latency test (MSLT) scores among patients with mild to moderate OSA. Similar results were reported for a study[5] in which the maintenance-of-wakefulness test was used. In contrast, an earlier study[6] documented a partial improvement in MSLT scores among patients with moderate OSA. More recently, a study[7] comparing therapeutic and subtherapeutic CPAP quantified changes on a modified maintenance-of-wakefulness test and demonstrated a positive impact of CPAP at therapeutic settings.

These reports are consistent with the findings of Kribbs et al,[8] who documented that MSLT scores improved from 3.1 minutes at baseline to 5.5 minutes at follow-up among a sample of patients with moderate OSA. In this study, the follow-up period was an average of 75.8 days (range=30 to 237) of CPAP treatment. These results, while of significance, highlight the potential limitations of CPAP therapy. The use of CPAP for the entire sleep period is likely to be critical to the normalization of MSLT scores. For example, studies in normal subjects have demonstrated that shortening time in bed (and, thus, total sleep time) results in systematic increments in their level of sleepiness, when determined by the MSLT. Specifically, a study[9] in which subjects were allowed to spend 8 hours, 4 hours, 2 hours, or no time in bed yielded a systematic shortening of their sleep latencies on the MSLT on the following day that correlated with the amount of time that they had spent in bed. In this context, patients who use CPAP for only part of the night are left untreated for the portion of the night spent without CPAP. Thus, a recurrence of

sleep fragmentation and oxygen desaturations is experienced by these patients. The partial recurrence of OSA limits the benefits that may otherwise be derived from CPAP.

The aim of this study was to evaluate the response to CPAP therapy as manifested by modified MSLT scores under one of two CPAP use conditions.

Random assignment of OSA patients was made to either a group using CPAP for less than 6.5 hours per night or a group using CPAP for more than 7.5 hours per night. Both groups were evaluated during the first week of CPAP treatment.

Subjects

Eligible subjects were clinic patients who were diagnosed with OSA based on 8-hour clinical polysomnography (CPSG). Of the patients diagnosed with OSA, who had a respiratory event index (REI) $\geq$10, only those who elected CPAP therapy were eligible for entry into this study. For entry into the study, subjects were required to have a regular nocturnal sleep schedule and were to be without any current psychiatric diagnosis. Subjects were required to be free of any illicit drugs and free of any medications that act on the central nervous system. Subjects continued to use all other prescribed medications. Subjects received a CPAP education session given by a trained technician. During this session, mask fitting and an actual trial of CPAP (with the patient seated in a comfortable recliner) were completed to ascertain patient's acceptance of this form of therapy. Participation in the study was discussed with prospective participants following the CPAP education session. Informed consent was obtained from all participating subjects.

Procedures

Subjects were instructed to refrain from caffeine and/or alcohol consumption for at least 5 hours prior to arrival at the laboratory. Before subjects arrived at the laboratory for their CPAP titration at 9 pm, their group assignments (less than 6.5 hours or more than 7.5 hours) were randomly determined. Subjects completed an overnight 8-hour CPSG for CPAP titration purposes. CPAP was initiated at a setting of 5 cm H2O and the pressure was increased by 1 cm H2O at intervals of 10 to 15 minutes until respiration and sleep continuity were normalized. The therapeutic pressure setting was determined on the morning following titration by a board-certified sleep medicine physician.

After arising, subjects remained in the laboratory for a modified MSLT. Nap opportunities were given at 9:30 am, 9:55 am, 10:20 am, 10:45 am, and 11:05 am. The naps were concluded after three consecutive epochs of stage-1 non–rapid–eye-movement (NREM) sleep, the first epoch of any other stage of sleep, or 20 minutes of wakefulness.

Following the modified MSLT, subjects were given a CPAP machine set at their prescribed pressure settings and equipped with a microprocessor that recorded compliance. Subjects were informed of their group assignment and were encouraged to use their CPAP machines every night while at home for nights two through seven.

On the eighth night of the study, subjects returned to the laboratory for an additional CPSG and modified MSLT. Subjects assigned to the $\leq$6.5-hours group were recorded for

6 hours (1 am to 7 am), while subjects assigned to the ≥7.5-hours group were recorded for 8 hours (11 pm to 7 am). The morning after the follow-up CPSG, the CPAP machines were downloaded to obtain compliance data for the nights spent at home. The night recordings and modified MSLTs were scored in 30-second epochs according to the criteria of Rechtschaffen and Kales.[10]

Results

The two groups had significant evidence of sleep-related breathing disorders at the time of diagnosis. The group assigned to ≤6.5 hours of use per night had an apnea index (AI) of 29 and a hypopnea index (HI) of 20, while the group assigned to ≥7.5 hours of use per night had an AI of 32 and a HI of 20. Their prescribed CPAP pressures were also comparable (11.5±2.2 and 11.1±2.5 cm H2O, respectively), and resulted in an improvement of sleep-

disordered breathing (REI <10). During the six nights at home, the ≤6.5-hours group averaged 5.4±1.5 hours of CPAP therapy per night, while the ≥7.5-hours group averaged 8.1±0.6 hours of CPAP therapy per night (P<.01).

In both groups, the CPAP use at home per night was comparable to the amount of CPAP therapy received on the follow-up CPSG. On the second visit to the laboratory, a week later, the two groups differed in sleep efficiency as a result of their scheduled time in bed. The ≤6.5-hours group spent significantly less time in bed on the return CPSG and had a sleep efficiency of 92%, while the ≥7.5-hours group achieved a sleep efficiency of only 86%.

The modified MSLT scores were analyzed; they showed that, while both groups were comparable at baseline (≤6.5-hours group=7.1±4.4 minutes and ≥7.5-hours group=7±3.2 minutes), they differed at the follow-up visit. The ≥7.5-hours group had a significantly higher modified MSLT score (8.5±5.2 minutes), compared with the ≤6.5-hours group (4.4±4.4 minutes, P<.05).

Discussion

The modified MSLT has been previously used among clinic populations with complaints of EDS.[11] The modified MSLT procedure has also been used in evaluating the effects of naps of different durations on the subsequent propensity to fall asleep among patients with narcolepsy and healthy sleep-deprived or alert subjects. The results of this study[12] showed that the modified MSLT effectively differentiated various levels of sleepiness. Based on these experiences, the modified MSLT was considered a viable alternative for the objective evaluation of sleep propensity among OSA patients, in particular, because the modified MSLT would further facilitate subject participation.

In the present study, the adherence to the two different CPAP schedules resulted in a differential pattern of polysomnographically determined sleep propensity. Clinical practice and research reports on CPAP compliance, however, have systematically shown that actual CPAP use by patients is less than ideal. These studies[6,13] usually report CPAP compliance at less than 5.5 hours per night. During the first week of CPAP therapy,

Rosenthal et al[14] evaluated CPAP compliance in a population of severe-OSA patients (REI=67±44). Compliance was found to be only 4.2 hours per night. A more recent study,[15] which evaluated CPAP compliance among a population of mild OSA patients (REI=18±6), found the rate of compliance to be 4.1 hours per night during the first week of treatment. The same rate of CPAP compliance was found when these patients were evaluated a year after the initiation of treatment.

These studies were important in helping to determine the amount of time that subjects were asked to use CPAP every night. The ≤6.5-hours group was intended to parallel the compliance rates documented by other researchers. While it is not possible to know, based on the design of this study, whether patients stayed in bed for longer periods of time, we were able to monitor their actual CPAP use.

An additional issue of interest is the rate of change on MSLT scores as a result of the initiation of CPAP therapy. A study by Lamphere et al[16] investigated the resolution of sleepiness in three groups of OSA patients who received CPAP therapy and were evaluated using the MSLT at different time intervals. Patients who received CPAP therapy for 2 weeks were found to have higher MSLT scores than patients who had received CPAP therapy for only a night (6 minutes). Both of these scores were significantly higher than baseline values (3.4 and 3 minutes, respectively). These results demonstrate that the recovery of alertness requires more than a night of normalized breathing during sleep. Further improvement was noted in the group that was evaluated after 6 weeks, but this did not reach significance when compared with the group evaluated at the 2-week follow-up. These results illustrate that, while the normalization of breathing is immediate, the change in MSLT scores is delayed by at least several days.

A previous study[17] evaluating adherence to CPAP therapy and its effects on MSLT scores demonstrated that the enforcement of CPAP use can accelerate the improvement of MSLT scores. In that study, patients were randomly assigned to one of two groups following CPAP titration: one had an enforced CPAP-compliance schedule and the other had an unenforced CPAP-compliance schedule. Subjects in the enforced-compliance group were asked to sleep in the laboratory for 5 days and were monitored while using CPAP for 8 hours each night. Subjects in the unenforced-compliance group were provided with CPAP machines set at their prescribed pressures and were told to follow their regular sleep schedules at home for 5 days. They were told to use their CPAP machines for their entire sleep periods, but were not instructed to make any changes in their habitual sleep schedules.

While their CPAP compliance was differential (8 hours per night versus 6.6 hours per night for the laboratory and home groups, respectively), the study was flawed because of the inherent bias introduced by having the laboratory group monitored significantly more closely. Nevertheless, on the sixth night after titration, both groups returned to the laboratory. Upon their return to the laboratory, both groups slept for 8 hours and had MSLTs the following day. The results showed that the change in MSLT scores after 6 nights on CPAP was comparable to the one documented for the present study.

A limiting factor in the treatment of OSA patients with CPAP is the lack of consistent data revealing predictors of compliance. Some research reports[18] have suggested that snoring, severity of sleepiness, and the REI may be predictors of CPAP compliance, but no overall consensus is available. An additional limiting factor might be related to the CPAP instrumentation itself. Such a possibility has not been fully evaluated. It is possible that, for some individuals, nasal symptomatology and the effects of using the interface for several hours result in sleep disruption that limits their ability to meet the ideal level of compliance.

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Long-term compliance rates to continuous positive airway pressure in obstructive sleep apnea: a population-based study

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STUDY OBJECTIVES: To determine long-term compliance rates to continuous positive airway pressure (CPAP) therapy in patients with obstructive sleep apnea enrolled in a comprehensive CPAP program in the community. DESIGN: Prospective cohort longitudinal study. SETTING: University sleep disorders center. PATIENTS: Two hundred ninety-six patients with an apnea-hypopnea index (AHI) > or = 20/h on polysomnography. INTERVENTIONS: A CPAP device equipped with a monitoring chip was supplied. Within the first week, daily telephone contacts were made. Patients were seen at 2 weeks, 4 weeks, 3 months, and 6 months. RESULTS: Of the 296 subjects enrolled, 81.1% were males. Mean +/- SD AHI was 64.4 +/- 34.2/h of sleep; age, 51 +/- 11.7 years; and body mass index, 35.2 +/- 7.9 kg/m(2). The mean duration of CPAP use was 5.7 h/d at 2 weeks, 5.7 h/d at 4 weeks, 5.9 h/d at 3 months, and 5.8 h/d at 6 months.

The percentage of patients using CPAP > or = 3.5 h/d was 89.0% at 2 weeks, 86.6% at 4 weeks, 88.6% at 3 months, and 88.5% at 6 months. There was a decrease in the Epworth Sleepiness Scale (ESS) score of 44% by 2 weeks of therapy. The patients continue to improve over the follow-up period, with the lowest mean ESS score observed at 6 months. With multiple regression analysis, three variables were found to be significantly correlated with increased CPAP use: female gender, increasing age, and reduction in ESS score. CONCLUSION: A population-based CPAP program consisting of consistent follow-up, "troubleshooting," and regular feedback to both patients and physicians can achieve CPAP compliance rates of > 85% over 6 months.

Compliance with continuous positive airway pressure therapy: assessing and improving treatment outcomes

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Although nasal continuous positive airway pressure (CPAP) is generally effective in correcting sleep-related respiratory disturbance and associated daytime sequelae in obstructive sleep apnea syndrome (OSAS), resistance to and intolerance of CPAP poses a serious limitation to its use. Failure to comply with treatment has been reported to be as high as 25 to 50%, with patients typically abandoning therapy during the first 2 to 4 weeks of treatment. Reasons for discontinuing CPAP therapy have been primarily related to issues of mask discomfort, nasal dryness and congestion, and difficulty adapting to the pressure. Although there has been great variability in the reported rates of CPAP compliance, there have been few systematic studies to evaluate barriers to CPAP compliance or ways to improve compliance.

Early identification of CPAP-related tolerance problems or barriers, psychological factors, and the predictive value of pretreatment background variables (i.e., age and gender) may enhance compliance with therapy. An important goal for OSAS management is the development of intervention strategies and educational approaches that minimize side effects and maximize patient compliance. A new classification is presented, along with suggestions and ideas for intervention.

Determinants of compliance with nasal continuous positive airway pressure treatment applied in a community setting.

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Objectives: To assess determinants of nasal continuous positive airway pressure (CPAP) compliance when applied in a community setting.Background: One-third of obstructive sleep apnea patients eventually refuse CPAP therapy. Treatment outcomes may be improved by identifying predictors of CPAP failure, including whether management by primary care physicians without sleep consultation affects results. Methods: Polysomnogram, chart review, and questionnaire results for regular CPAP users (n=123) were compared with those returning the CPAP machine (n=26).Results:

Polysomnographic data and the presence of multiple sleep disorders were only modestly predictive of CPAP compliance.

Striking differences in questionnaire responses separated CPAP users from non-users, who reported less satisfaction with all phases of their diagnosis and management. Rates of CPAP use were not significantly different between patients managed solely by their primary care physician or by a sleep consultant. Conclusions: Polysomnographic findings are unlikely to identify eventual CPAP non-compliers in a cost-effective fashion. Improvements in sleep apnea management may result from addressing the role of personality factors and multiple sleep disorders in determining compliance. In this practice setting, management by primary care physicians did not significantly degrade CPAP compliance.

Glossary of Sleep-Related Terms

Airflow
Airflow is the amount of air moving in and out of the nose or mouth during breathing. This is sensed by the devices we place under the nose. There a number of different devices that we may use to measure the airflow.

Apnea
An apnea is an absence of breath, or the absence of airflow coming from the nose or mouth and/or absence of respiratory effort. We monitor for apneas with the airflow sensor placed under the nose, and the respiratory belts that measure breathing.

Arousal
An arousal is an interruption of sleep. Arousals may be associated with apnea, hypopnea's (partial apneas}, leg movements, teeth grinding, or noise. When there are too many arousals, sleep is not maintained and is fragmented or broken-up.

Awake state
Non-sleep state, eyes open, alert.

Bi-Level Positive Pressure Ventilation
This is the same basic mechanical device as the C.P.A.P. except with two types of pressure. As with C.P.A.P. pressurized air is blown thru a hose into a mask that helps to splint the airways open. The splinting of the airway helps to eliminate most of the sleep disordered breathing and snoring. Bi-Level positive pressure ventilation is different than CPAP because it generates two completely separate pressures to aid in inspiration and exhalation. The higher pressure is called IPAP (inspiratory positive airway pressure) and assists during inhalation. The lower pressure is called EPAP (expiratory positive airway pressure) which is the expiratory pressure needed to splint the airway and eliminate apneas.

Bi-level is commonly used with individuals who are unable to tolerate high CPAP pressure, or for individuals who do not suffer from a total obstruction of the airway but experience a partial obstruction. Partial obstructions may limit the ability for complete gas exchange in the lungs, this is calles hypoventilation, or alveolar hypoventilation. Gas exchange in the lungs occurs between the alveoli and capillaries at the microscopic level.

Bradycardia
Low heart rate.

Bruxism
Grinding teeth

Cannula
Tubing placed under the nose to either deliver oxygen, read the values of exhaled carbon dioxide, or measure changes in pressure to determine airflow.
Central Apnea
This type of apnea (cessation of breathing) differs from obstructive apnea in that the patient exhibits no breathing effort during the period absent of airflow.
Continuous Positive Airway Pressure (C.P.A.P.)
A mechanical device which blows pressurized air thru a hose, into a fitted mask (patient interface device). The positive pressure delivered by the CPAP device helps to splint the airways open, thus eliminating sleep disordered breathing.
Electrode
An electrode is a wire with a small cup on the end of it. Electrode paste is placed in the wire. The paste helps the electrode make contact with the skin so that we can obtain the electrical activity of the brain (EEG), muscle movements, heart rate, etc. The wires or electrodes are placed on the patient to act as a conductor by receiving electrical impulses which are then sent to the computer and translated into information.
Electrocardiogram (ECG)
The ECG looks at the heart rate and for any abnormal heart rhythms. Atrial fibrillation is commonly associated with sleep apnea. Children will have more variability in their heart rate than adults.
Electroencephalogram (EEG)
The EEG refers to the channels that record brain waves to the computer. We use these channels to determine when sleep occurs, to differentiate sleep from wakefulness and to determine the different stages of sleep.
Electromyogram(EMG)
The EMG electrodes are placed on the chin and legs to determine chin tone or muscle movement. We use the information to look for teeth grinding (bruxism) or leg movements. The muscle tone of the chin also helps us when scoring the sleep study to determine REM sleep.
Electrooculogram (EOG)
Electrodes placed next to the eyes in order to pick up eye movements. We are able to determine REM or dream sleep when the EEG slows down and there are frequent eye movements.
Epoch
One page of the sleep study or 30 seconds.
End-tidal carbon dioxide (ETCO2)
This is used to measure the exhaled carbon dioxide during each breath. The value is usually measured at the nose with nasal prongs. This information is helpful in diagnosing sleep disordered breathing when there are not obvious episodes of apneas. ETCO2
First night affect
The effect of the sleep lab environment on the quality our guests sleep during the first night of recording. Sleep is usually reduced in quality compared to home.
Heart Rate
How fast the heart beats. The heart rate tends to change often in children.
Hypopnea (partial apnea)
A reduction in airflow of greater than 50% of the normal breath. To be “scored” these events must last 10 seconds or longer in adults, shorter events are often scored in infants and children due to the faster respiratory rates.
Hypersomnia
Excessive deep sleep, or lengthened sleep period.
Impedance
Is a way of measuring how well the electrode is connected to a patient and how well

the electrode is functioning.

Montage

A specific arrangement by which the study is displayed for the technician.

Multiple sleep latency test (M.S.L.T.)

This study is performed after a regular nights sleep study. The M.S.L.T. is used to evaluate individuals who experience daytime sleepiness with no clear reason as to why. The study results are useful in diagnosing a condition called narcolepsy.

NREM sleep stages

For adult sleep, Stages 1, 2, 3 and 4 within the Sleep Period. For child sleep, Stages 1, 1/2, 2, 3, 3/4 and 4 within the Sleep period.

Obstructive Sleep Apnea

A diagnosis used for individuals who stop breathing during sleep due to an obstructed airway with continued respiratory effort.

Oxygen Saturation (O2)

This is read by the sensor placed on the finger, often called the “E.T. finger” because of the red light.

Polysomnography/polysomnogram (P.S.G.)

An overnight sleep study. A PSG uses the EEG, EMG, EOG, EKG, and respiratory variables to study an individuals sleep and breathing.

Pulse Oximeter(sao2)

The device used to measure the oxygen levels in a patients blood.

Rapid eye movements (R.E.M.s)

This occurs during REM sleep. We are able to determine that the child is dreaming and in REM sleep by looking for frequent eye movements.

REM sleep

Stands for Rapid Eye Movement. The Rapid Eye Movement stage is where we see all the eye movements, even though the rest of the body is totally relaxed. REM is the stage of sleep where dreaming occurs.

Respiratory effort

The amount of movement or effort your child uses to breath during the sleep study. We use the respiratory belts to watch for changes in effort. The belts are placed on the chest and stomach.

Respiratory events

These are periods of abnormal breathing during sleep. These may be apneas, partial apneas, or central apneas. We count all of these events during sleep in order to determine what type of treatment may be beneficial. To be identified and scored as a respiratory event an episode of reduced airflow must last 10 seconds or longer in adults, shorter events are often scored in infants and children due to the faster respiratory rates.

Sao2

This is read by the pulse oximeter and is the percentage of oxygen in the blood.

Sensor

An instrument used to measure an electrical signal and deliver the signal to the computer to be processed and changed to a recording that we are able to use to evaluate sleep and breathing.

Sleep Efficiency

This is the percentage of actual sleep time during the sleep study recording. This is used to evaluate the quality of the sleep on the night of the sleep study.

Sleep Architecture

States and cycles of sleep depicted as a whole study.

Sleep cycle

Is a complete cycle of sleep stages that happens about every 90 minutes until you are awake. Most children experience about 4 or 5 sleep cycles during the night. Sleep

disordered breathing will often interfere with the sleep cycles.

Sleep diary

An important tool used for daily entries of the patient's activities, bedtimes and naps. It is recommend that a sleep diary be recorded for at least two weeks prior to the sleep study. This tool is helpful and an important tool to help diagnose problems that could otherwise be missed.

Sleep Disordered Breathing

A general term used to describe abnormal breathing patterns during sleep.

Sleep Hygiene

Following a specific routine before bedtime that is conducive to good sleep. Examples are a regular bedtime, no T.V. or video games in the bedroom, low noise levels etc.

Spontaneous Arousal

An arousal from sleep that is not associated with a respiratory event, increased muscle tone, or environmental interference.

Stage 1 sleep

Occurs at sleep onset and after arousal from other sleep stages. This is a very light stage of sleep.

Stage 2 sleep

Occurs after stage one sleep. It is a light stage of non REM sleep. The majority of sleep for adults and older children is spent in stage 2. You can be easily awakened while in stage 2.

Stage 3 and 4 sleep

Are deep stages of sleep. Stage 4 is the deepest stage of all. Both stages are non REM and are often referred to as slow wave sleep. It is very hard to awaken someone from these stages. Arousals from stage 4 sleep may be associated with sleep walking, sleep terrors and confusion.

Tachycardia

Heart rate that is above the normal rhythm for age, sleep/wake state and activity.

Titration

This is when the technician monitors the patient very closely and raises the air pressure of the C.P.A.P or Bi-Level to eliminate apneas and snoring.

Total sleep time (T.S.T.)

The sum of all REM and NREM sleep time during the study, excludes time awake.

Post-Test

Select the ***best*** answer to each of the following items. Mark your responses on the Answer Form.

1. Forty-five percent of normal adults snore at least occasionally, and 25 percent are habitual snorers. Various methods are used to alleviate snoring and/or OSA. They include _____.

a. behavior modification
b. sleep positioning
c. Continuous Positive Airway Pressure (CPAP),
d. All of the above

2. Nasal CPAP delivers air into your airway through a specially designed nasal mask or pillows.

a. True
b. False

3. The mask "breathes" for you; the flow of air creates enough pressure when you exhale to keep your airway open.

a. True
b. False

4. CPAP is considered the most effective non-surgical treatment for the alleviation of snoring and obstructive sleep apnea.

a. True
b. False

5. CPAP compliance simply means that a patient is carrying out a prescribed treatment plan exactly as directed. In most cases, this will mean that their condition, disorder or disease is cured, or under control.

a. True
b. False

6. When patients don't comply with treatment, the consequences can be very negative for the patient. The patient continues suffering from the complex of OSA symptoms and complications that can include _____.

a. fatigue
b. confusion
c. falling asleep at inappropriate times
d. All of the above

7. Obstructive sleep apnea-hypopnea syndrome (OSAHS) is characterized by repetitive episodes of airflow reduction (hypopnea) or cessation (apnea) due to upper airway collapse during sleep.

a. True
b. False

8. Obstructive sleep apnea-hypopnea syndrome (OSAHS) is characterized by repetitive episodes of airflow reduction due to pharyngeal narrowing, leading to acute gas exchange abnormalities and sleep fragmentation and resulting in neurobehavioral and cardiovascular consequences.

a. True
b. False

9. Large population-based studies have associated OSAHS with _____.
and, and retrospective data indicate.

a. cardiovascular disease
b. cerebrovascular disease
c. increased mortality
d. All of the above

10. Usage patterns and problems with CPAP vary among patients. The minimum effective CPAP use time is unknown, but improvements in objective daytime sleepiness have been shown when average use is less than 4 hours per night. Nightly vs intermittent (suboptimal compliance) CPAP use patterns may be established within the first several weeks to a month.

a. True
b. False

11. CPAP therapy is often difficult to tolerate and patients frequently stop using it because of discomfort. The nasal mask interface may cause pressure sores, persistent air leakage, claustrophobia, nasal congestion, and other side effects that may lead to suboptimal compliance.One study suggested that CPAP compliance might be improved with intensive CPAP support, where these problems can be addressed through a multidisciplinary team approach.

a. True
b. False

12. There is now a universally accepted definition of CPAP compliance.

a. True
b. False

13. In a study cited in the course, with the application of and compliance with CPAP therapy, there was a marked improvement in the patients' daytime sleepiness as measured by the ESS. In just 2 weeks following initiation of CPAP therapy, they observed a 44% relative reduction in the average daytime sleepiness for our cohort of patients.

a. True
b. False

14. Study findings suggest that high CPAP compliance rates are achievable in the community through a comprehensive CPAP program that provided free CPAP devices, extensive education, and follow-up services for symptomatic OSA patients with moderate-to-severe disease through a multidisciplinary team approach.

a. True
b. False

15. The lack of subjective benefit from CPAP appears to be a major factor having detrimental influences on adherence and compliance.

a. True
b. False

16. Good basic education and support are essential in ensuring good CPAP compliance.

a. True
b. False

17. Every effort should be made to minimize the side effects of CPAP in order to enhance the quality of patients' lives and to increase the likelihood of compliance.

a. True
b. False

18. Many factors affect CPAP compliance, but education and support, rather than in-laboratory CPAP titration, appear to be pivotal. Self-adjustment of CPAP at home will provide equal or superior efficacy in the treatment of obstructive sleep apnea (OSA) as compared with in-laboratory titration.

a. True
b. False

19. In many research articles, it is commonly reported that long-term compliance for sleep apnea patients nationally averages 50% to 60%. Despite this advancement, there remains a segment of the patient population that historically does not tolerate CPAP therapy well.

a. True
b. False

20. The degree to which patients' complaints are reversed by a therapeutic intervention has no predictive value regarding patient satisfaction and treatment compliance.

a. True
b. False

21. Polysomnographic findings are unlikely to identify eventual CPAP non-compliers in a cost-effective fashion.

a. True
b. False

22. Before the invention of the nasal CPAP, a recommended course of action for a patient with sleep apnea or habitual snoring was a tracheostomy, or creating a temporary opening in the windpipe.

a. True
b. False

23. Obstructive sleep apnea-hypopnea syndrome may be considered part of a spectrum of sleep-related breathing disorders that includes the upper airway resistance syndrome (UARS) and primary snoring.

a. True
b. False

24. Manual continuous positive airway pressure (CPAP) titration in a sleep laboratory is costly and limits access for diagnostic studies.

a. True
b. False

25. The specialty of sleep disorders medicine, recognized officially by the American Medical Association in 1996, has continued to grow tremendously.

a. True
b. False

26. Data on the effect of OSAHS treatment on blood pressure are mixed; some intervention studies show a positive effect.

a. True
b. False

27. There is a large sector of the medical sleep community that is not readily accepting of the dental appliance option for patients who are intolerant to CPAP.

a. True
b. False

28. A population-based CPAP program consisting of consistent follow-up, "troubleshooting," and regular feedback to both patients and physicians can achieve CPAP compliance rates of > 85% over 6 months.

a. True
b. False

29. Reasons for discontinuing CPAP therapy have been primarily related to issues of _____.

a. mask discomfort
b. nasal dryness and congestion
c. difficulty adapting to the pressure
d. All of the above

30. Early identification of CPAP-related tolerance problems or barriers, psychological factors, and the predictive value of pretreatment background variables (i.e., age and gender) may enhance compliance with therapy.

a. True
b. False

31. Polysomnographic findings are unlikely to identify eventual CPAP non-compliers in a cost-effective fashion. Improvements in sleep apnea management may result from addressing the role of personality factors and multiple sleep disorders in determining compliance.

a. True
b. False

32. Airflow is the amount of air moving in and out of the nose or mouth during breathing. This is sensed by the devices we place under the nose. There a number of different devices that we may use to measure the airflow.

a. True
b. False

33. OSA is a diagnosis used for individuals who stop breathing during sleep due to an obstructed airway with continued respiratory effort.

a. True
b. False

34. The Rapid Eye Movement stage is where we see all the eye movements, even though the rest of the body is totally relaxed. REM is the stage of sleep where dreaming occurs.

a. True
b. False

35. Titration is when the technician monitors the patient very closely and raises the air pressure of the C.P.A.P or Bi-Level to eliminate apneas and snoring.

a. True
b. False

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